Editorial & Publishing Offices:
MACMILLAN & Co., LTD.
ST. MARTIN'S STREET
LONDON, W.C.2

Telegraphic Address:
PHUSIS, LESQUARE, LONDON

Telephone Number:
WHITEHALL 8831

Vol. 144 SATURDAY, SEPTEMBER 2, 1939 No. 3644

A PALÆOBOTANICAL RETROSPECT

IT is one of the privileges of the study of science to-day that it gives to the student a perspective and a sense of proportion that has a wonderfully steadying effect in these anxious days, and thanks to the happy decision of Sir Albert Seward to leave technicalities aside in his presidential address to the British Association, which is printed in the Supplement to this issue of NATURE, his listeners and his readers have had their thoughts tuned to a sense of distance and of time which permits a saner contemplation of the present temporary European turmoil.

No subject could be more appropriate for contemplation by a Scottish audience, or indeed by any British audience, at this holiday season, than a retrospective survey of one of the most popular holiday retreats, the Western Isles of Scotland; but the simple language in which problems of the widest import and of the most intriguing nature are expounded, makes the address at the same time a fascinating example of the scientific method in operation—as Sir Albert expresses it "of how a student asks questions of Nature and does his best to interpret the answers". For a few magic minutes it must have been a great joy to his listeners to yield themselves completely to the direction of so competent and persuasive a guide, and with him to take an excursion "into a world that knew not man", for the Western Isles are contemplated when they were part of a great continent, the Thulean continent or province, at a time some sixty million years ago, and human beings have not appeared upon the scene until all but one fiftieth of this period has transpired.

If thus vast tracts of time are passed in review and at the same time problems raised which demand a mental grasp of distanees that cover a large part of the northern hemisphere, the picture is built up by a creative imagination working with the most scrupulous regard for detail, and probably no feature of the address would more impress the newcomer to such problems than the suggestive use that is made of careful, detailed observations upon fossil plant material, the debris perhaps of a forest floor, preserved through the ages by the processes of sedimentation or the fortuitous action of volcanic agencies. The detailed sculpturing of a pollen grain needs microscopic examination with careful optical control, but through it may be built up a 'spectrum' of pollen dispersion in peat or coal which is as revealing to the botanist as is the spectrum of a star to the astronomer. Careful methods of clearing may render details visible in a fossil cuticle which permit the recognition of a microscopic leaf parasite and thus some suggestion as to the moisture of the climate in which this leaf-born cuticle had flourished. The student of the living plant must admit that if he had studied details of form and venation of leaves with the thoroughness of his palæobotanical colleague, very often his claims as to the affinities of living plants would be more securely founded.

Sir Albert's reconstruction of the Thulean forest is based in part upon the earlier collections from the plant-containing beds of the islands of the Inner Hebrides, and particularly the layers near the base of the basaltic lavas on Ardtum Head, near the south-western corner of Mull, but it is based mainly upon recent and as yet unpublished data obtained by Sir Albert himself, in association with Mr. W. N. Edwards, keeper of geology in the British Museum, and Dr. J. B. Simpson of the

Geological Survey; they are, then, the result of a felicitous partnership of botanists and geologists and illumine the field of study of both sciences.

The conifers of this corner of the globe in these far-off days were certainly more varied and diverse than the Forestry Commission would venture to utilize in trying once more to reclothe their rocky flanks and mist-swept valleys with forest. *Sequoia sempervirens* they might plant, and also Abies, but Cryptomeria and Cephalotaxus are surprising genera to find in a Hebridean flora; they are confined to-day to the Far East, as is also that other remarkable gymnosperm, *Ginkgo biloba*, the maidenhair tree, a doubtful native now of any country but still much valued in cultivation in China and Japan.

Indeed one striking result of this survey is the remarkable preponderance in the probable generic sources of fossil pollen, and in the debris of woody gymnosperms and angiosperms, of generic names which now are associated with the flora of the Far East. Many a keen gardener in Sir Albert's audience—and in a Scottish audience there would be many—must have been intrigued to realize that, in introducing to the garden such plants as Cercidiphyllum for its beautiful autumnal foliage, or such a flowering shrub as an Abelia, he was re-introducing to a Hebridean environment a genus which flourished in the Thulean forest sixty million years ago; the wheel has come full circle.

It is evident that the former existence of this vast continent, reaching into the Arctic Circle and linking North America through Greenland with Europe and even the Far East, has considerable significance in relation to problems of plant distribution of the present day—a point that is made clear by Sir Albert's suggestive discussion of selected genera of flowering plants. This naturally leads to a reference to hypotheses of drifting continents, discussed by Prof. W. W. Watts at the Norwich meeting of the Association. Sir Albert recognizes that geophysical methods of precision have as yet failed to furnish evidence of any sliding of the earth's crust, but he points out that "geologists and palæontologists contribute facts that are incontrovertible however much they seem to be in opposition to the views of students whose primary interest is in geophysical problems".

On such vexed questions of evolution as the origin of the flower and the angiosperm carpel, this Hebridean flora of sixty million years ago is silent. So comparatively recent a time is this in terms of evolutionary processes, that the forest has already taken on the general aspects of a modern sub-tropical forest with seed plants dominant.

Sir Albert discussed in this connexion the fascinating problems raised by Prof. T. M. Harris's observations upon forest beds at Scoresby Sound in Eastern Greenland, which suggest that a luxuriant and uniform vegetation once occupied an area stretching from central Germany to southern Sweden and a thousand miles farther north, beyond latitude 70° N. In those days arctic voyagers, had there been any, might have felled tall trees for their masts within the Arctic Circle, and the fossil records from both arctic and antarctic regions are a constant reminder that the problems of climate of past time raise questions of far-reaching implication.

In fact the address showed how the palæobotanical approach stimulates interest, gives significance to the minutest detail and adds depth and width to our contemplation of everyday phenomena. Inevitably, therefore, the thought arises, as it emerged at the end of the address, why is this enrichment of everyday experience usually denied to us during school years. But a plea for the introduction of geology to a curriculum which is already so overloaded that even biology still often demands a place in vain is scarcely likely to receive more than a sympathetic hearing.

Perhaps the solution is along the lines followed now in an increasing number of schools, where up to the School Certificate stage the formal divisions of science are no longer recognized and general science is studied; when the material for exercises in scientific method can thus be selected in accordance with their claim upon experience, the soil will certainly win its way into the class-room and thus, for certain schools, where perhaps some member of the staff has made contact with geology in his years at the university, the rocks and their story and that of the agencies at work moulding the earth on which we live will be permitted to weave their own spells upon the unspoilt imaginations of the coming generation, which may thus become alive to the possibilities of interest which the subject holds. It will then perhaps add still more, for a coming generation, to the foundation of a serenity of outlook and saneness of poise, conspicuous in this year's president, which if more widely spread among us, would to-day have its definite value in preserving the community from the onslaught of the 'war of nerves' now so loudly proclaimed as in full spate.

THE FUTURE OF MANKIND

The Fate of Homo Sapiens

An Unemotional Statement of the Things that are Happening to him Now, and of the Immediate Possibilities Confronting Him. By H. G. Wells. Pp. vi+330. (London: Martin Secker and Warburg, Ltd., 1939.) 7*s*. 6*d*. net.

NO one having reached maturity in the reign of Queen Victoria and having survived into our present epoch can be expected to feel altogether at home. In those days, distant not so much in time as in atmosphere, although everyone believed in inevitable progress, "there was a widespread feeling that nothing more of primary importance was ever likely to happen". It was precisely because of this static condition of things that the public so eagerly took to Mr. Wells's futuristic romances.

But all that has changed; the dominant question is: What is likely to happen? And the answers given to it are disturbing. Mr. Wells's answer is no exception:

"There is no reason whatever to believe that the order of nature has any greater bias in favour of man than it had in favour of the ichthyosaur. . . . I perceive that now the universe is bored with him, is turning a hard face to him, and I see him being carried less and less intelligently and more and more rapidly . . . along the stream of fate to degradation, suffering and death."

Mr. Wells does not consider that this fate is as yet absolutely inevitable, though to escape it there will have to be something in the nature of a wholesale conversion of the species to more rational habits of thinking and behaving; and he does not appear to believe that this is very likely to happen.

The gravest menace to humanity at present springs, as everyone recognizes, from war. The Marxists regard war as a natural symptom of an economic system in decay; but Mr. Wells repudiates Marxism. For him, war has been from primitive times a natural form of social bloodletting, caused by a surplus of young men. In the pre-scientific epoch only relatively puny means of destruction were available. But the inventive urge of the species has altered the situation for the worse. Instead of being "part of the accepted human rhythm", war has become "a galloping consumption of the human species".

Thus a situation has developed which threatens the human race with decline and ultimate extinction. The question is: Are human powers of self-adaptation sufficient to enable the species to adjust itself to this new situation? The trouble is that speed seems to be called for; there is no time for the older and slower methods of adaptation. Of course, man's possession of a unique brain gives him an advantage; and the readjustment will have to be a *mental* one. This mental readjustment, says Mr. Wells, must involve three main essentials: (1) the idea and tradition of war must be eliminated; (2) "The vast and violent wastage of natural resources in the hunt for private profit, that went on in the nineteenth century, must be arrested and reversed by the establishment of a collective economy for the whole world"; (3) the resultant world organization must be "of an active, progressive, imaginatively exciting nature", so that the surplus energy of youth may be absorbed by it and not allowed to run to destructive waste in war.

These three principles, peace, collectivism, and incessant new enterprise, are interdependent and inseparable. In Mr. Wells's view, the League Covenant failed because it completely disregarded these principles. It overlooked the problem of the restless young men; and it gave no attention to "the absolute necessity of reconstructing economic life upon a collectivist basis throughout the world".

In order to bring about the mental adjustment involving acceptance of his three principles, Mr. Wells calls for "such a *kultur-kampf* as the world has never seen before". Nothing less than the entire reconditioning of our mental life is required. What our generation needs is the kind of enlightenment that the French encyclopædists provided in the eighteenth century. It was the ideas of Diderot and his associates that "materialised in the American and French revolutions and in a great heartening of the creative spirit of man". Is it possible for this achievement to repeat itself on a larger scale to-day?

Mr. Wells does not believe that our present educational institutions are likely to effect the change. The common schools "are essentially conservative institutions, adapting the common man to the social order in which he finds himself", and they fail to provide "the scientific vision of life in the universe". Thus the existing educational organization "needs to be recast quite as much and even more than the political framework".

It will be plain that what is here advocated is nothing less than a complete change of mentality, a redirection of public interest. The question is

whether a new programme of intellectual education, even of the most enlightened kind, would suffice to achieve the change. The real trouble is that the educated, even those with an education in natural science, can be enlightened intellectually, without being in the least enlightened emotionally. What is needed is a transvaluation of values, and this is not to be achieved easily. Mr. Herbert Read has suggested that we should "try the experiment of educating the instincts instead of suppressing them". Many educationists (who as a class are very much more progressive and alive to realities than Mr. Wells would seem to be aware) are trying to work along these lines, but it is work that will not be done in a day. Meanwhile, as Mr. Wells says, the need is urgent.

This is a timely and sincere book and written without fear of giving offence. J. C. H.

TRADITIONS AND FUTURE OF BRITISH DEMOCRACY

The Anglo-Saxon Tradition

By George Catlin. Pp. xii + 286. (London: Kegan Paul and Co., Ltd., 1939.) 10*s*. 6*d*. net.

THE Anglo-Saxon tradition has "impregnated the political institutions of the Anglo-Saxon world on both sides of the Atlantic and has provided patterns to all Europe and to the lands that look to Europe". Prof. Catlin seeks, in this book, to re-clarify the political and moral content of that tradition and to derive from it guidance as to the course which should now be taken by the Anglo-Saxon peoples. This tradition is contrasted with the conception of man's purpose in the world that arises from Fascist and Communist ideology.

Whatever may be the truth for German and Russian minds in these concepts, they are not for British. The fulfilment of life in the Anglo-Saxon meaning is in the preservation of our own cultural traditions, while we carry out the changes in economic and social organization that are necessary so that this tradition may flower and bear fruit for all the citizens instead of, as now, mainly for a favoured few. Prof. Catlin urges upon us that if we are to serve our mission in the world we must develop a new vigour of thought and action inspired by humanist philosophy. Only by moving forward with courage and wisdom in the light of our own cultural history will we be saved from drifting unwittingly into errors which will make us appendages to one or other of the totalitarian camps.

The Anglo-Saxon populations of the British Empire should be bound closer together in economic and political co-operation. They have an immense opportunity and responsibility to develop the vast area of the Colonial Empire "until the time comes to transfer it, as a substantial basis of wealth and power and a *peculium* to the direct rule of Geneva or a World State which requires such sovereign possession to give it dignity". They should take the first step towards a new federalism in the world by establishing now a community of interest in all fields with the United States of America.

Perhaps the most striking thing about the book is that, while it is written by a member of the Labour Party, it expresses a view with regard to the mode of economic, social and political evolution which will be acceptable to all Conservatives of progressive mind. The pressure of crises, economic and political, in the modern world, is producing such new formulations of policy as to make the party alignments preposterous. There are many things which Prof. Catlin says that I do not agree with. Curiously enough, the main theme of my criticism would be that he is too hard upon the Soviet Union. I should have interpreted its experiment as having a far greater content of social value and of progress than this book gives it credit for. On the other hand, I should have been less tolerant of the German Nazis than, in some passages, he appears to be. There are differences of emphasis but they are of a kind which show how completely obsolete is the old party conflict.

The main contentions of the book are stimulating; they form a valuable contribution to a current of opinion which has been growing in strength in recent times. The issues dealt with are of vital importance to ourselves and to the world. Those who appreciate that we are not going to find our way out of the present impasse without some hard thinking would do well to read this book with care.

H. MACMILLAN.

MAGNETISM: OLD PROBLEMS AND NEW METHODS

(1) Ferromagnetism
The Development of a General Equation to Magnetism. By Dr. J. R. Ashworth. Pp. xiii+97. (London: Taylor and Francis, Ltd., 1938.) 7*s.* 6*d.* net.

(2) Modern Magnetism
By Prof. L. F. Bates. Pp. ix+340. (Cambridge: At the University Press, 1939.) 16*s.* net.

ALTHOUGH the books of Dr. Ashworth and Prof. Bates both deal with aspects of magnetism, their difference in character and purpose is such as to illustrate very forcibly the limitations of any formal system of book classification by title or subject.

(1) Dr. Ashworth has performed a useful service in collecting together, in abbreviated form, his own contributions to magnetism. It is more than forty years since he published his first paper on the subject, but most of the twenty-two papers listed have appeared since 1912. The experimental work described includes extensive investigations on the temperature and field dependence of the magnetization of iron, nickel and cobalt, with particular reference to anhysteretic properties, studies of the temperature coefficient of magnets, and measurements of specific heat. In the attempt to develop a general equation covering ferromagnetic behaviour, to which much attention is devoted, use is made of an equation having formal analogies with the van der Waals equation of state for fluids. In this ferromagnetic equation of state, field and intensity of magnetization correspond to pressure and density, and the reciprocal of the paramagnetic Curie constant to the gas constant in the fluid equation. Critical constants are evaluated for the different ferromagnetic materials, and empirical relations between these constants are obtained.

In seeking to correlate a wide range of facts in this particular way, Dr. Ashworth has pursued a very independent course. Many of the relations are striking, but as the task of tracing their significance in the light of the interpretation of ferromagnetism which is now generally adopted is not undertaken, most readers will be left in a state of doubt as to what has, in fact, been achieved. The answer would appear to be that there is a considerable amount of purely empirical correlation covering a limited range of ferromagnetic phenomena, which may be useful for empirical purposes, but that, without much further consideration and development, the fundamental significance of the relations obtained remains obscure. In spite of this drawback in the treatment of one of the main themes, the book is well worth examination by those concerned with magnetism, just because of its almost complete independence of approach to the problem of ferromagnetism. Moreover, some of the experimental investigations are along lines which for some time have been rather neglected, but are now again becoming of central interest.

(2) Prof. Bates, who collaborated in some of the earliest successful investigations on the gyromagnetic effect, and whose subsequent researches have been mainly concerned with magnetism, has written a general survey of recent work. He has been impressed by the difficulty found by students in acquiring a satisfactory knowledge of magnetism, and he believes this to be largely due to the subject having been treated far too much from a strict theoretical point of view. He has, accordingly, given prominence to the description of fundamental experiments. The theoretical side is not excluded—indeed, the first chapter gives a very comprehensive account of the classical and quantum theoretical background—but usually questions of theoretical interpretation are considered only briefly in connexion with experimental work to which they are relevant.

There are good accounts of methods for the production and measurement of fields, and for examining the magnetic properties of isotropic substances and crystals. The details given of the more widely applicable methods, and the practical comments, will provide a most useful guide to those embarking on similar work. Adequate footnote references will facilitate the task of finding fuller information. There are shorter descriptions of more specialized apparatus.

Some of the most outstanding examples of recent experimental technique are admirably presented in chapters on atomic and nuclear moments, and on the gyromagnetic effect. The last part of the book deals mainly with ferromagnetism. Methods for the measurement of saturation magnetization and the determination of the Curie point are described, the general theory is outlined, and there are accounts of the magnetic properties of metals and alloys. The various magneto-thermal effects are fully considered. Finally, a résumé is given of work on magnetostriction and the Barkhausen effect.

Inevitably, in a book of this kind, there is some overlapping with other books dealing generally with magnetism, but the author has chosen his main topics so as to include a considerable amount of material "which a student cannot readily find

elsewhere". Though the book, if considered alone, might seem to give a rather ill-balanced survey of the field of magnetism, when considered in relation to other books, it is just this lack of balance which makes it a most useful addition to the literature of the subject. The author's own work has been very varied, and in writing of experimental technique, he includes information of a kind which could only have been gained from practical experience. The book will be particularly valuable to those carrying out experimental work on magnetism. The clear presentation will appeal to the student, and the account of much recent work will be appreciated by physicists and others who wish to keep up to date with the subject.

In one of these two books the author, who has zealously followed up an individual line of inquiry, presents his findings almost unconcerned with their relations to the wider scheme. In the other, the author surveys a wide range of work with a keen appreciation, and with a sense of the interlocking character of scientific investigations. The books present, on one hand, a particular approach to an old problem, and on the other, a broad survey of the new methods for attacking this problem and others related to it. E. C. S.

THE LIVING PLANT

Botany of the Living Plant

By Prof. F. O. Bower. Third edition. With the Assistance of Prof. J. M. F. Drummond and Dr. George Bond. Pp. xii + 700. (London: Macmillan and Co., Ltd., 1939.) 25*s*. net.

PROF. BOWER'S text-book is so well known for its many excellent qualities that it needs no introduction to British students and teachers. It is evident, however, that during the sixteen years which have elapsed since the second edition was published, many fresh discoveries have been made which it is desirable to include in an up-to-date text-book. In preparing this new edition Prof. Bower has been assisted by Prof. J. M. F. Drummond and Dr. G. Bond.

No change has been made in the general arrangement of the book, which was fully described in NATURE at the time when the first and second editions appeared (NATURE, **104**, 274; 1919: **112**, 51; 1923); but the sections dealing with certain aspects of plant physiology, cytology and genetics have been largely rewritten or amplified. In particular the chapter on the living cell has been considerably modified, and there is new information on the internal regulation of growth by plant hormones, and also on the influence of the length of day on the flowering of plants.

The sections dealing with mycorrhiza and the fixation of nitrogen by the bacteria present in the root nodules of leguminous plants have also been considerably modified. Recent advances in cytology are well summarized, although necessarily in a somewhat condensed form, and the relationships of cytology to genetics and between genetics and evolution are discussed. There is also a short article on vitamins. On the morphological side the most interesting innovations include a section dealing with the Psilophytales, a more complete treatment of the Equisetales, and a new discussion of the origin and significance of alternation of generations.

The author has also included a chapter on the relation of size and form in plants. In this he cites and discusses examples which support his working hypothesis that "Elaboration of form as the size of the individual increases is a means of maintaining the surface-volume ratio, which would otherwise tend to fall to a point of physiological inefficiency". Prof. Bower admits quite candidly that his views on this subject are not yet fully proved, but he asks meanwhile that his readers shall maintain that "wholesome frame of mind styled by Huxley as 'suspended judgment' until by extended observation this theory of Size and Form shall have been either disproved, or raised to a level of reasonable probability, with Galileo's Principle of Similarity as its foundation". He makes the interesting speculation that the primary form of a plant may be initiated by a hormone "under control of the apical cone".

As one would expect, the book is characterized by a welcome simplicity of expression throughout, and no intelligent student can complain of inability to understand its contents. Opinions differ from time to time concerning what should or should not be included in a text-book of botany, and in these days of specialization it may be felt by some, whose botanical interests are somewhat circumscribed, that their own particular subjects have not received adequate attention. But it is difficult to see how a more balanced and broad-minded introduction to general botany could have been written. It is much to be hoped that it will be even more generally used than the two earlier editions.

C. R. METCALFE.

ELECTRON OPTICS

(1) Electron Optics
Theoretical and Practical. By L. M. Myers. Pp. xviii+618+68 plates. (London: Chapman and Hall, Ltd., 1939.) 42*s*. net.

(2) Theory and Applications of Electron Tubes
By Prof. H. J. Reich. Pp. xviii+670. (New York and London: McGraw-Hill Book Co., Inc., 1939.) 30*s*.

(3) Fundamental Electronics and Vacuum Tubes
By Prof. A. L. Albert. (Engineering Science Series.) Pp. ix+422. (New York: The Macmillan Company, 1938.) 20*s*. net.

(4) Electron Optics
By the Research Staff of Electric and Musical Industries, Ltd. Compiled and written by Otto Klemperer. (Cambridge Physical Tracts.) Pp. x+107. (Cambridge: At the University Press, 1939.) 6*s*. net.

(1) MR. MYERS is to be complimented on producing the first book on the subject to be published in Great Britain, and a truly comprehensive and readable book. He has spared no pains in bringing the matter up to date, and his exhaustive survey of the whole field includes some eight hundred references.

Roughly, the first half of the book is mathematical, and gives the fundamental electron-optical laws and a detailed examination of electric fields which brings in the electron trajectory. This leads up logically to the treatment of various types of electron lenses and their aberrations. The mathematical derivations are supplemented by experimental details which bring out the important applications, but more stress could profitably be laid on the physical interpretation of the formulæ deduced.

The second half of the book is mainly descriptive. It deals with the electron multiplier, electron microscope, and some of the latest developments. The immediate application of electron-optical principles in the discussions of these various devices makes stimulating reading, since the author has participated in some of the researches which are described.

On the whole, the book is well balanced. Apart from a number of simple misprints, the illustrations are excellent, particularly those showing gravitational models of the electric field. Aspects of the subject which would enhance the value of the book are (1) a discussion of deflection distortion and design of deflecting systems, and (2) graphical ray tracing involving a discussion of lens design. The section on the space-charge effect is not clear, and needs further amplifying. A most useful addition would have been a discussion of ion focusing and its application to atomic disintegration research.

(2) It will always remain a matter for argument as to what ought to be included in a book of such wide scope as Prof. Reich's, if the subject is to be adequately treated. The author has made a wise choice of subject-matter. He brings to the student of radio-engineering and the future television engineer just those fundamentals necessary for an intelligent appreciation of this wide field. After two preliminary chapters on the physics of their internal action, the behaviour of vacuum tubes and an analysis of circuit conditions are discussed in eleven chapters.

The introduction of the series expansion for the alternating plate current as well as the numerous applications of graphical analysis should prove most helpful to the student. Glow and arc phenomena are discussed at greater length than is usual. This is all to the good, because of their expanding practical applications. The chapters on photo tubes and instruments dependent for their action on the use of vacuum tubes complete an excellent book. The author has brought all his experience as a teacher to bear in his lucid method of presentation. The large collection of references adds greatly to the value of the book for all engaged in research in these fields.

(3) Prof. A. L. Albert's book can worthily take its place among the excellent group of American works on vacuum tubes which have appeared in the last few years. The author has succeeded in his task of introducing to engineers the fundamental principles of electronics.

The first three chapters are devoted to an examination of sources and methods available for production of electron streams. Their utilization in diodes and multi-electrode valves is fully discussed in the next four chapters. After this, vacuum tube amplifiers, oscillators, and modulators are dealt with. Chapters on photo and cathode ray tubes complete the book.

The treatment is non-mathematical throughout, and the illustrations and numerical applications of formulæ aptly bring home the important points that require stressing. A more graphic and detailed account of the electric field as affecting electron motions would have added to the stimulating explanations given.

The book can be recommended to physicists as well as to engineers.

(4) Mr. Klemperer's monograph is an excellent introduction to the study of electron optics. While written mainly for graduate students, the development of the subject almost from first principles extends its usefulness. The cardinal points of electron lenses determine their behaviour and properties. These are deduced on the basis of field plots, and the parallel optical concepts are neatly worked into the scheme. Other important chapters deal with aberrations and magnetic lenses, and a final chapter is devoted to applications. The author has performed a difficult task very well indeed. His choice of subject-matter as well as his method of giving examples of immediate practical applications of theory should prove most stimulating to all his readers. L. JACOB.

PHARMACEUTICAL CHEMISTRY

(1) Bentley and Driver's Text-Book of Pharmaceutical Chemistry

Revised by Dr. John Edmund Driver. Third edition. Pp. ix + 624. (London: Oxford University Press, 1937.) 16*s*. net.

(2) Drugs and Galenicals: their Quantitative Analysis

By Dr. D. C. Garratt. Pp. xiv + 422. (London: Chapman and Hall, Ltd., 1937.) 25*s*. net.

(1) THE pharmaceutical student has, as a rule, only a short period of intensive and continuous study in which to acquire that somewhat heterogeneous collection of knowledge about the inorganic chemicals, synthetic organic substances and components of natural drugs, which constitutes the pharmaceutical chemistry of an examination syllabus. A large part of this knowledge is concerned with the standards of quality specified for the drugs of the British Pharmacopœia, and the methods by which deviations from these standards may be detected. It is reasonable, therefore, that the authors of this text-book should begin with a series of chapters dealing generally with methods for the characterization and analysis of substances used in medicine, and they have spared no pains to secure clarity and simplicity in their statement and explanation of the principles on which these methods are based.

This section is followed by one dealing with inorganic compounds, written so far as possible on the usual lines of a text-book on inorganic chemistry, but distinguished by the addition of that special information required for therapeutic purposes. Thus, the reader is not told how to prepare oxygen—he should already possess that information—but how it is manufactured, what impurities associated with different manufacturing processes may be present, and how he may ascertain whether these impurities are within the limits allowed by the Pharmacopœia.

More than half of the book is devoted to organic chemistry, dealt with on the usual systematic lines, but with each group of substances illustrated by its outstanding pharmaceutical examples.

By this method of treatment the authors have constructed, from what appears at first to be rather difficult material for systematic exposition, a coherent and well-balanced text-book, which contains much interesting information not usually found in books on chemistry written for students. That the book is appreciated by its special clientele is clear from the fact that, since the first issue in 1925, it has been reprinted once, and is now in its third edition.

(2) The first reasonably efficient process for the estimation of morphine in opium was published over half a century ago. Since then there has been a steady output of papers on the same subject and recent activity indicates that even now the last word has not been said. Few other drugs have received so much analytical attention as opium, but most of them have had a good deal said about them, possibly because the pharmaceutical analyst is an observant and uncompromising individualist, who is happiest in using a method in the evolution of which he has himself played some part, or as Dr. Garratt puts it, "individual bias is often responsible for the fact that a method which is found unreliable by some analysts may, in other hands, give good results". Whatever may be the reason, the literature on drug analysis is enormous and Dr. Garratt has earned the thanks of his fellows by putting into this book the results of his critical survey of this mass of material, and giving them the benefit of his seventeen years' experience as drug analyst to the London County Council in trying, comparing and checking selected methods.

The book being intended for professional analysts, explanations of processes are not given and the familiar British Pharmacopœial methods are not quoted, unless comment has to be made, or new applications suggested for them. A particularly useful feature of the book is the inclusion of methods for the analysis of mixtures and compounded drugs of various kinds, and the term

drug is not interpreted too narrowly, insecticides such as derris and pyrethrum being also dealt with.

Great pains have been taken to secure accuracy and to achieve completely the objective indicated by the title of the book. Here and there small points can be found to cavil at, but there can be no doubt that the book will prove useful to all whose business it is to be engaged regularly, or occasionally, in the examination of drugs, simple or compounded. T. A. HENRY.

THE EARTH'S CRUST: ITS FABRIC AND FOUNDATIONS

Architecture of the Earth

By Prof. Reginald Aldworth Daly. (Century Earth Science Series.) Pp. xiii+211+47 plates. (New York and London: D. Appleton-Century Co., Inc., 1938.) 12*s*. 6*d*. net.

IT is on record that Prof. Daly's students, in his practising days, used to chant "Every morning in the year, Daly has a new idea". But Prof. Daly's claims to the gratitude of his scientific brethren lie as much in his popularization of the results of geological research as in his many contributions to its progress. In this volume he takes as his text a happy adaptation by the late Prof. P. Termier, director of the Geological Survey of France, "The earth declares the glory of God", and succeeds in justifying it, telling his story in a manner that the intelligent layman can understand. In this matter of popular scientific writing, a trite remark from the author's preface is worth reproduction: such popularization of science requires "effort by the specialist to be an adequate reporter; effort by listener and reader to imagine".

The "Architecture of the Earth" represents the slightly expanded material of lectures on "The Crust of the Earth", given under the auspices of the Norman Wait Harris Foundation of the Northwestern University in May 1937. Special emphasis is placed on the discoveries and classifications made since the opening of the present century; in particular, new light is thrown on old problems as a result of the recent spectacular growth of the young science of geophysics. Four main problems are selected for study: mountain-building, the eruption of lava, the diversification of rocks once molten, and the stability of continents and island masses. Up-to-date results of the analysis of earthquake records and gravity measurements are utilized.

The author expounds in simple language the thesis he recently published in less accessible form—to the effect that the 'third' layer of the earth's crust consists of glassy basalt rather than ultrabasic rocks like dunite and pyroxenite, as the geophysicists are disposed to postulate. Thus the earth-shells consist, from the surface downwards, of Sial (the sedimentary and granitic layer of which the continents are composed), with the 'intermediate' layer, the Sima of crystallized basalt underlying the continents and forming the floor of the oceans, otherwise termed the gabbroic layer, and the 'third' shell of vitreous basalt. Concerning the constitution of these layers as deduced from the behaviour of earthquake waves, Prof. Daly expresses himself as not convinced of the force of the argument that, since a fluid cannot transmit shake- (transverse) waves, and such waves are propagated to depths of 60 km. or more, a vitreous shell cannot exist there. He contends that it still remains to be demonstrated that shake-waves cannot be propagated in melted basalt exposed to a minimum pressure of 17,000 atmospheres. Recalling the fact that Gutenberg, from his earthquake studies, deduced the possibility of a vitreous layer at 60–70 km. depth, he refers to Ide's experiments on the passage of sound waves through Pyrex glass and Volarovitch's statement that, up to a temperature of 1100° C., molten basalt at only one atmosphere of pressure has effective rigidity and can transmit shake-waves. From recent laboratory work, the determination of the velocity of shake-waves suggests that the effect of high temperature somewhat offsets that of high pressure.

Prof. Daly further argues that dunite and pyroxenite (supposed to form the 'third' layer, because specimens of these rocks collected from the earth's surface most nearly satisfy the density and velocity requirements) are actually loose-textured and porous rocks which could not exist in that condition in the depths. He suggests interesting experimental work which would throw light on these and other problems, and looks hopefully in one chapter for a Croesus to supply the funds, and in another to a Maecenas to furnish the equipment. Whether his new views are accepted or not, they are characteristically stimulating, and his well-written and richly illustrated volume is worthy of attention from both specialists and laymen. P. G. H. BOSWELL.

THE COLLAPSE OF CIVILIZATIONS

AT a time when Western civilization seems to be in danger of self-immolation, and in the East the greatest of Empires has yet to show whether it has lost that power of resilience, which has been its most striking characteristic in the history of a civilization extending over a period reckoned not in centuries, but in millennia, some of us may well turn to the past for a sign which will act as a guide to the underlying laws which govern the rise and decadence of peoples. It is this that justifies a reference, belated though it may seem, to a Friday Evening Discourse at the Royal Institution on "The Collapse of Ancient Civilizations", delivered by Mr. Stanley Casson, on February 24.

Mr. Casson, in surveying the rise and fall of peoples and cultures in antiquity, drew the interesting moral—much to the point in the present stress of rearmament—that whereas war-like aggression was a destructive force, hurrying more often than not to its own destruction, militarism, in the sense of preparedness for war, was an essential of survival. In truth, however, his argument developed a broader implication; and it may not be without present advantage to see how, when observed through the eyes of an archæologist, the main trends of movement revealed by this department of research afford analogies which may aid in the attainment of a judicial and detached view in perspective when estimating present-day tendencies.

Now Mr. Casson points out that so far as our evidence goes, organized warfare begins with the emergence of man from the simple stage of the food gatherer into the neolithic phase of food-production by agriculture—the food gatherer, who lives from hand to mouth, raids the agriculturist in order to seize his surplus supplies of food. The agriculturist—short of becoming a serf, as might have been pointed out—survives only on condition that he organizes a successful system of defence. "So War, the scourge of mankind developed", while militarism, using the term in no derogatory sense, came into being "for the purpose of dealing with War—a part of civilization—its defensive aspect". In other words, "war is the biological process by which a less developed or successful people attempts to get something for nothing, by simple seizure, by violence and by assault", while "the immediate response of the civilized community to imminent warfare is defence, and defence implies what can be called Militarism".

Mr. Casson proceeds to develop his thesis by examining in broad outline the development of ancient civilizations, beginning, naturally, with that of the Sumerians in Mesopotamia. Thus the earliest written records of the Sumerians relate on one hand to the storage of surplus corn, on the other to wars and the treaties which concluded them. There is a further significance in the fact that this surplus of corn had given rise to a leisured class, the priests, who controlled it, and they also controlled education, another consequence of the existence of a surplus. Again, almost as soon as they had perfected the urban mode of life, which is their great cultural legacy to the world, they also perfected a defensive machine with which to protect it. They created an army to defend themselves against the less cultured peoples, possibly still food-gatherers of the mountains to the east, and devoted to it all their intellectual gifts. By the end of the fourth millennium, they possessed armaments which "anticipate by many centuries those of the Homeric and Classical Greeks". Walls and an organized army preserved civilization in its earliest stages; and, Mr. Casson argues, so firmly did this militaristic defence establish it, that civilization in Mesopotamia survived in fact longer and with more persistence than in any other part of the globe.

This may seem a hard saying, in view of the duration attributed by tradition to the civilization of China, which goes back to a date little, if at all later, than that of Mesopotamia; but Mr. Casson makes his meaning clear when he goes on to argue and to demonstrate that the civilization founded by the Sumerians not only contributed to the foundation of European civilization—he is evidently a diffusionist—but also endured in an unbroken stream, notwithstanding dynastic and racial changes, though subject to interruption by the Mongols, down to historical, or even, it might be said, to present-day times. In all this period, he points out, there has been no collapse of civilization, no real breakdown.

Turning to Egypt, there is here too an immensely ancient mode of life, largely conditioned by geographical and physical factors, which survived. While its history runs concurrently with Mesopotamian, neither Greece nor Rome were ever more than superficial controls on Egypt. Egyptian culture was too deep-seated, too well-protected to be displaced. Its protection was the desert, which flanked its valley, and the excellent

organization of its armies. It survived the attacks of the sea-raiders of the thirteenth century B.C., the Libyans, the Bedouins, and the nomads, who came to raid it and seize its surplus wealth. "Egypt was throughout her history, as well organized against barbarian as was Sumer."

Mr. Casson is fully alive to the importance of the negative instances which lend their support to his theory. These he finds in Crete and the Hittites. Crete, he points out, is "the first complete collapse of a complete civilization". On the basis of a culture derived from the Middle East and to some degree influenced by Egypt, the Cretans forged a peculiar and unique civilization unlike any other before or since. Living on an island surrounded by a sea, difficult even for large ships to-day, they were isolated and free from attack. Therefore, unlike Sumerians and Egyptians, they had no standing army, no militaristic organization, other than for ceremonial, and no navy. Apparently they depended on the fact that the barbarous peoples of the mainlands would be unequipped to cross the dangerous seas to attack them; and so they built no walls. Unwisely, however, they conveyed to those barbarous peoples some knowledge of their wealth and culture; and it is therefore scarcely likely to be accidental that at the very time that Cnossos wanes, Mycenæ waxes. Though it cannot be proved as yet, it is a sufficiently satisfactory working hypothesis that when about 1400 B.C. the whole civilization of Crete crumbles and collapses, it may have been due to the barbarous Greek-speaking peoples of the mainland, the forerunners of the heroic period. It is instructive to note that the Myceneans adopted the externals of Cretan culture, rather than its intimate spirit. Mycenean culture is both cruder and more magnificent than Cretan.

An even more instructive point which Mr. Casson makes is that this great heroic age, of which Homer sang, did not endure. "Examine history," says Mr. Casson, "and you will always find that heroes have little lasting power or survival value. . . . The heroes of an heroic age are busily engaged in squandering the accumulated capital of their predecessors, and living on the carcase of a higher civilization than their own." The Homeric civilization in its brief duration and decadence finds a parallel in the heroic age of England after the departure of the Romans, and in Ireland, as well as in the exploits of the Crusaders in Byzantine history.

Again, of the Hittites, without following the details here, it may be said that the fall of the Hittite Empire—the empire of a people who left us no heritage of culture and had no survival value—is to be attributed to the fact that they allowed a people more barbarous than themselves to encroach on the south and west, and lived with a permanent open door at the back of their fortress. They ignored Europe and Europe destroyed them.

A pregnant contrast is afforded in the respective fates of Greece and Rome. Rome perished and Greece survived. For in the Byzantine Empire—Greek in spirit, in intelligence and in organization, in all three of which it was superior to Rome at any period—Greek culture persisted nearly a thousand years longer than the main structure of Roman culture. Roman culture, even if it left the indelible marks of its great civilization on some of the peoples of Europe, for their eternal advantage, passed away as a complex structure of civilization as certainly as did the Hittite.

The inferences which Mr. Casson draws provisionally at this point may be stated as follows:

(1) A civilization that lives in a world, where there are deeply marked divergences of culture and development, must be fully defended to survive. Its defence must take the form, as did the defence of Byzantium, of attack, if necessary, and of alertness always. As Mr. H. G. Wells has said, "An empire that awaits attack is doomed".

(2) Only where civilizations are of equal development and status can militarism be expunged from the list of essentials for survival. Nowhere in history have civilizations of equal status lived in proximity, unless we make the exception of Egypt and Babylonia.

(3) If the civilization you have created has not enough innate driving force and survival value of its own to transform barbaric peoples who intrude into it, and to assimilate them rapidly, then your civilization will break down by a process of steady barbarization. If you once admit the less civilized and their customs into your own highly developed structure, you will find them sapping its foundations, whittling it away, and leaving you nothing but a ruin.

In regard to this last, which to many will seem the most important in its application by analogy to modern conditions, Mr. Casson goes on to point out that while both the Mesopotamian peoples and the Egyptians admitted barbarians, it was the barbarians who vanished, and the same is true of Greece, but that though Rome admitted barbarians early, in course of time it was the Romans who were barbarized. Rome, he says, fell to an internal assault, which was an assault on the spirit as well as on the structure of Roman life, and the fabric fell an easy prey to the direct attack of still more barbarous barbarians. In support, Mr. Casson instances the evidence of recent archæological excavation in Britain, in which it has been shown how Roman villas were used as squatting places by the barbarous successors

of the Romans on such sites. "You must deal with barbarians spiritually as well as physically," he says, "and convey to them that your civilization has qualities which they can envy and emulate, as well as wealth they can loot." Contrast the survival value of Greece. The Greeks absorbed foreign blood without losing their Greek character; and their invention, the *polis*, had not only a prodigious attraction as a mode of life to barbarians of all kinds, but also it carried Hellenism from Greece to the Indus. The Greeks saw that you must present to a people of a lower order of development something which will attract them to you, not with the desire to take your surplus wealth, but to emulate your mode of life.

"Such reflections," concludes Mr. Casson, "on the breaks and pauses in the course of civilization have some value for those who argue by analogy. . . . We should pocket our pride and glance at some of our past failures. For they are chastening to those who indulge in that greatest weakness of the civilized—complacency."

INSECTS IN THE UPPER AIR

BY DR. A. D. IMMS, F.R.S.

THE investigation of insects in the upper air has so far been conducted on a very limited scale. Probably the first attempt to collect insects from such an environment was that made by E. P. Felt, in the United States in 1926, who used a special kind of trap attached to the lower wings of an aeroplane. Since that year, several experimental attempts have been made to explore the insects and other arthropods of the upper air. Thus in 1931, 1932 and 1933 more extended flights by aeroplanes, with insect traps attached, were made in the United States.

The first European entomologist to attempt this line of investigation was L. Berland who, in 1934, used an aeroplane with specially devised nets attached to the wings and controlled from the cockpit. Many flights were made and all were in the vicinity of Paris. Very similar methods have also been used in Asia Minor and at Oran in Algeria. In 1937, J. A. Freeman made collections of insects in the upper air by using kites along the Great Lakes in Canada.

Between 1932 and 1935 Freeman, working in England in conjunction with A. C. Hardy, made a study of insect drift, using nets attached to 300 ft. masts of a wireless station. Specially constructed kites enabling samples to be obtained from given altitudes were also used. In 1938, A. C. Hardy and R. S. Milne published a detailed account of aerial tow-netting from kites with closeable nets attached.

The most extensive investigation of insects in the upper air is that described by P. A. Glick in Technical Bulletin No. 673 (May, 1939) of the U.S. Department of Agriculture. Under the title of "The Distribution of Insects, Spiders and Mites in the Air", a detailed account of the work, running to 150 pages, is given. The collecting was done during the five-year period 1926–1931, and special kinds of trap fitted to the wings of diverse types of aeroplane were employed. It appears that more than 1,300 flights were made at Tallulah (La.) and 44 flights in Mexico. More than 30,000 insects and spiders were taken at altitudes ranging from 20 ft. to 15,000 ft. and were most abundantly captured in the month of May. Eighteen orders of insects together with arachnids were represented. In the Tallulah collections there were more than 700 species belonging to more than 200 families. The order Diptera was the most abundant and was represented by nearly three times as many specimens as in any other order: Coleoptera followed next as regards numbers taken.

The highest altitude at which insects were captured was 14,000 feet and, as a general rule, their frequency of capture was in inverse ratio to the altitude. Among individual orders of insects, only 21 specimens of dragonflies were collected, and the author states that this is due to their rapid flight and their ability to avoid the oncoming aeroplane. He records having observed Odonata (probably *Anax junius*) keeping up with, and sometimes even flying ahead of, an aeroplane that was travelling at 90 miles or more per hour. Homoptera were captured at almost every altitude up to 14,000 feet. More than half of the Coleoptera taken belonged to the families Carabidæ, Staphylinidæ, Chrysomelidæ and Curculionidæ or, in other words, to the largest groups of these insects. Altogether 4,420 specimens belonging to 191 genera of Coleoptera were captured in the traps and the maximum elevation was 11,000 ft. Lepidoptera (32 species) were not captured higher than 5,000 ft. Hymenoptera, represented by nearly 250 genera, were obtained at nearly all elevations up to 14,000 ft. Their dominant representatives

belonged to the Parasitica and the ants. Of the Diptera the most abundant families represented were the Chloropidæ with 2,227 specimens and the Chironomidæ with 701 examples. Culicidæ were represented by 111 specimens belonging to seven genera.

Among apterous forms, 1,461 spiders were captured, one example occurring at 15,000 ft. A single example of *Pulex irritans* at 200 ft. is recorded. Numerous Apterygota are mentioned, besides wingless Hymenoptera, etc., and larvæ.

Among the various factors governing the distribution of insects in the upper air the size, weight and buoyancy of individual forms are discussed together with the influence of temperature, dew-point, barometric pressure, wind direction and velocity, convection, light intensity, etc. Of these, and other factors, temperature is regarded as the most important agency regulating the numbers of insects to be found in the air at any given time.

With the great number of aeroplanes now in regular use in the world, numerous ways are offered for insects to find shelter in these vehicles and so become carried from one territory to another. New means for the dispersal of dangerous insect pests are thus afforded. Air currents are also believed to be an important accessory factor in the distribution of the destructive pink bollworm in the United States. During the five years of flying to collect insects, many kinds of these creatures were found either in the cockpit, fuselage or cabin of the planes used, but no special collections were made.

OBITUARIES

General the Hon. C. G. Bruce, C.B.

BRIGADIER-GENERAL THE HON. C. G. BRUCE died on July 12 at the age of seventy-three years.

Charles Granville Bruce, born in 1866, was a son of the first Lord Aberdare. Probably no man since the time of the Schlagintweits had a wider knowledge of the Himalaya than Bruce. No one ever had so intimate a knowledge of so many of its peoples. Bruce's climbing experience extended from the Safed Koh to Sikhim. He was with Conway in his notable expedition to the Karakorum, and with Mummery and Collie in the first attempt on Nanga Parbat. The snows of Khagan and Kulu were his happy hunting grounds. In 1907, the jubilee year of the Alpine Club, he nearly arranged the first exploration of Mount Everest; but at the last moment the plan was vetoed in London by John Morley, who feared Russian suspicion. Again in 1910 he got leave from the late Maharaja to explore Everest from the Nepalese side; but at the last moment this had to be given up for fear of arousing religious hostility.

By profession a soldier, Bruce was an acknowledged master in the difficult technique of fighting on the North-West Frontier. His influence with his own Gurkhas was remarkable, and his greatest contribution to mountaineering came through his wide knowledge of the tribes of the Himalaya. He was the first to use trained Gurkhas for serious mountain work. He started the Baltis of Kashmir and the Bhotias of Garhwal on the upward path, a lead which Kellas ably followed. But his great discovery was the value of the Sherpa, a Tibetan tribe long settled in Nepal. These, with their purer Tibetan cousins, have been the mainstay of every Himalayan expedition of recent years. The cause of his success was his sympathy with and knowledge of the languages and habits of these very varied peoples.

In 1923 Bruce was elected president of the Alpine Club. In 1915 he was awarded the Gill Memorial Prize and in 1925 the Founder's Medal of the Royal Geographical Society. But it was the adventure, not scientific interests, which absorbed him during his climbing holidays and longer expeditions. Of the latter, the Everest expedition of 1922 stands out. He made an ideal leader. Yet it is as a companion, the perfect one, that I most remember him, especially with Arnold Mumm and myself in Garhwal in 1907. He was the most invariably considerate, and pleasant, and uncomplaining companion it is possible to imagine. Not even the injured knee which deprived him of climbing Trisul with his devoted Subadar Kharbir Burathoki drew one word of disappointment or complaint from him. Bruce's name became a household word: but only his friends knew his real worth.

T. G. LONGSTAFF.

Prof. Archibald Young

PROF. ARCHIBALD YOUNG, who died in Glasgow on July 24 at the age of sixty-five years, had held the regius professorship of surgery in the University of Glasgow since 1924, when he succeeded Sir William Macewen. He had come under the influence of his predecessor, and this partly accounted for his leaning towards the surgery of the nervous system, to which he had regularly contributed since his service in the South African War. Moreover, this choice of speciality was natural in one whose clinical inclinations were coloured by the minutest examinations of clinical cases.

Prof. Young was at his best in dealing with

conditions in which careful attention to the smallest details was essential for diagnosis and treatment, and to this characteristic may be attributed his success in dealing with fractures, with lesions of peripheral nerves, and with affections of the sympathetic nervous system. For many years his health was indifferent, and his work was carried on often in discomfort and not infrequently in pain; and it is a sad reflection that his last major contribution to surgical literature was a translation of Prof. Leriche's monograph on pain.

A man of the highest integrity and professional ideals, and of uncompromising opinions, Prof. Young instilled into all his students his example of steadfast devotion to duty. J. R. LEARMONTH.

WE regret to announce the following deaths:

Dr. W. C. Mansfield, geologist of the U.S. Geological Survey, on July 24, aged sixty-five years.

Dr. A. H. Trow, formerly principal of the University College of South Wales and Monmouthshire, professor of botany in the College during 1905–18, on August 26.

NEWS AND VIEWS

Science and the National Ideal

THE world stands on the brink of the abyss. Before these words appear in print, it may have taken the plunge; and ten million men will already have entered on the initial phase of a struggle, of which none can foresee the end, except it be in disaster. The efforts of those, who during the last twenty years have striven to reconstruct a civilization shaken to its foundations by the war of 1914–18, have been frustrated by the incompatibility of their aims with the exclusive methods of national regeneration. In all the antagonisms of recent years, the voice of science, except where throttled by the political partisan, has been steadfast in support of freedom of thought and toleration—to those of this way of thinking, essentials of social and intellectual advance, but now threatened root and branch by the aggressions of a totalitarian nationalism.

SIR ARTHUR KEITH (*Sunday Times*, August 27), while admitting the close kinship of exclusive nationalism with the tribalism of the barbaric Dark Ages, sees in its spirit the mechanism of progressive development, and contrasts it with a cosmopolitanism which is lacking in force and colour. But in this contrast is he not guilty of a false antithesis, to which he is led by a too crude and outmoded interpretation of the Darwinian's force of natural selection? In the history of civilization, the struggle for existence has been resolved from one of brute force into a struggle for survival among ideas. Too true that often advancement has come about, and the world being what it is, must still at times come about by the aid of the driving force of the national idea. But more and more the struggle loses the character of national rivalry and becomes one in which we move, slowly it may be, towards a world order, which is not merely an undifferentiated cosmopolitan universalism, but an order to which each group, be it people, nation, or empire, by the development of its traditional culture to its highest power, may contribute something towards the common good and advancement of mankind as a whole. This is the faith and the ideal of a nationalism to which science must cling fast at all costs.

Education to Meet the Challenge to Democracy

SOME two thousand representatives of parents and teachers in the United States recently met at Cincinnati to discuss "The Purposes of Education in American Democracy" under the four heads: self-realization, human relationships, economic efficiency and civic responsibility. The proceedings culminated with a remarkable address by the president of the University of Wisconsin. American education, he said, entrusted as it has been to local inspiration, leadership and control, with emphasis on individual rights and individual liberty and but little sense of national responsibility, has for generations taught values which no longer conduce to a proper understanding of a world infested everywhere by a highly organized and efficient system of vilification and ridicule of the whole theory and method of democracy. The dictators are cultivating a common interest and a new goal; telling the masses that to save one's life one must lose it in devotion to a common social ideal. How can this be countered in a society split into groups which are at war with each other on political, social and economic fronts? Only by engendering an overriding devotion to what it wholeheartedly believes to be a worthier common social ideal. "Only a dynamic democracy can cope with a fact-facing fascism." The need is urgent. Only a conscious educational programme can produce the requisite sense of common purpose and common sacrifice, active, steady and constant. It "calls first of all for an understanding of democracy as a way of life and a nourishing of the underlying values upon which society depends for its existence. . . . Education must face this issue or lose its liberty and its opportunity". The address is reported in the July issue of *School Life*, the official organ of the Office of Education.

Use and Misuse of Science

In his presidential address "The Use and Misuse of Science" to the Royal Society of New South Wales, which has been reprinted in part from the *Journal and Proceedings* of the Society, Prof. J. C. Earl points out that control over Nature involves not merely the knowledge that in certain circumstances a known natural phenomenon will occur, but also the ability to arrange the stage so that the occurrence takes place when and where we will. Knowledge may be power, but it remains inactive until a conscious effort is made to use it. We can use the power we have constructively or destructively, and this responsibility cannot be regarded lightly. Our conduct must be determined by some motive and the moral issue cannot be evaded. Discussing the use of science, Prof. Earl termed research associated with the use rather than the extension of knowledge, secondary scientific research, in contrast to primary scientific research, which is concerned with the extension of knowledge as such. The latter he considered an essential duty of a university, the discharge of which would foster its other duty of maintaining cultural traditions. He urged that the tendency to foster secondary rather than primary research in the universities of Australia with the resources now available was dangerous and that the claims of the latter required more energetic support from within and without. In urging this larger and keener interest in fundamental work, Prof. Earl did not suggest, however, that secondary scientific work was less important, and he referred to the need for scientific work in Australia on Australian products.

Mental Disease and War

In a recent essay (*Hibbert J.*, 37, 513; 1939) on mental disease as a factor in the causation of war, Dr. Olof Kinberg, professor of forensic psychiatry at the University of Stockholm, remarks that though it is growing increasingly clear that war as a means of solving social problems is utterly futile, for the remedy is worse than the disease, many large countries are seeking to imbue even their children with an admiration for war and to do all they can to represent it as the most glorious exposition of national greatness, while other countries are making every possible effort to avoid war, though they are compelled to build up enormous armaments. Prof. Kinberg discusses some of the psychological features of modern society which may help to explain this paradoxical state of affairs. He points out that in order to mould public opinion the ruler must transform private citizens into a psychological mass and keep them in that condition for a considerable time. The production of this mass is brought about by the Press and the radio being in the hands of the Government, the formation of a bulwark against criticism and the persecution and destruction of anyone who dares to entertain different opinions.

Prof. Kinberg directs attention to the likeness between the qualities of the national mass and the paranoid personality which is characterized by touchiness, egoism, quarrelsomeness, inability to judge its own affairs impartially and a conceit and arrogance which sometimes takes the form of megalomania. At the same time the mass adopts towards its leader, however shabby and obscure his past may be, an attitude of servile submission which contains a strong infusion of magic and mysticism. A continuous interaction takes place between the national mass, whose passions are kept at boiling point, and the leader, who has himself shown from the onset abnormal psychical features of a paranoid character. Such a state of affairs, according to Prof. Kinberg, has been exemplified from the French revolution down to the revolutions of the present day.

Eiderdown Industry and Protection of Eider-Ducks

The numerous islands which border the north coast of the Gulf of St. Lawrence have long been a breeding ground of eiderducks. But it is only since 1933 that a supervised industry in the collecting and marketing of eiderdown has been established. During the past six years the export of cleaned eiderdown has increased five-fold, and the recognition of the value of the birds has led to active protection and encouragement of an increasing stock of nesting ducks. Where the eiderdown industry has been established severe penalties are enforced for their destruction or molestation. The collection of the down, it is reported by the Office of the High Commissioner for Canada, does not interfere with the regular hatching of the eggs, and as a result of this and of protection the colonies of eiders have been steadily increasing in numbers. For the purpose of eiderdown production, residents of the Gulf-shore area now lease from the Province of Quebec suitable coastal islands at a nominal rental for a period of five years, and each lessee is supplied with a permit under the Migratory Birds Convention Act authorizing him to collect, possess and sell eiderdown taken from the nests in his leased area. We trust that a close watch will be kept upon this new industry and that definite counts will be made by scientific observers at periodic intervals to test the effect of the trade upon the number of birds. The conditions of the leases granted to the down collectors are unknown to us, but it is hoped that some provision is made to check what might easily develop into ruthless destruction at the close of a period of lease, if the lessee suspected that renewal might not be granted.

Re-organization of the Cotton Industry

The Cotton Industry (Reorganization) Act, which has since reached the Statute Book, is the subject of a further broadsheet issued by P E P (Political and Economic Planning). The Cotton Industry Board to be appointed by the Board of Trade will be representative of all sections of the industry in addition to having three independent whole-time members, including the chairman, with special knowledge of the industry. The Board will appoint, partly from among its own members, a special Export Development Committee, which will have the particular

duty of making recommendations regarding the export trade. Cotton and rayon interests will be equally represented on the Committee and the other principal bodies in the industry will be the Cotton Industry Advisory Committee, charged with examination of the sectional schemes, and the Representative Advisory Council. Provision is also made for the establishment of a separate Rayon Industry Committee. Producers are compelled and merchants permitted to register with the Cotton Industry Board, but merchants will only be registered if they agree to abide by the contracts prescribed in sectional price schemes. Sectional schemes, which to become legally binding must be supported in a poll by the majority of the section concerned and approved by the Board, may relate to the elimination or reduction of redundant plant or to the fixing of prices. The broadsheet emphasizes the importance of marketing policy, the need for market research, the urgency of establishing central marketing arrangements, the necessity of a more enlightened labour policy than that which has short-sightedly sought exemptions from the Factories Act which reduced the juvenile working week from 48 to 44 hours, as well as the importance of implementing the permissive clause of the Act which allows the compensation of operatives displaced by redundancy schemes. Only long-term measures of this character can overcome the operatives' real and natural fear of technical change and eliminate the labour troubles which have contributed to the industry's difficulties.

Mr. W. Gavin, C.B.E.

IN further development of the organization which would be set up by the Government in the event of war to bring about an increase in food production in Great Britain, Mr. W. Gavin has been appointed agricultural adviser designate to the Minister of Agriculture and Fisheries. Mr. W. Gavin has already served in the Ministry of Agriculture, having been appointed in 1916 to act as assistant to the late Hon. E. G. Strutt, who was agricultural adviser throughout the war of 1914–18. Mr. Gavin afterwards became secretary and deputy director of the Army Cattle Committee, director of flax production and director of land reclamation. He is now the agricultural adviser to Imperial Chemical Industries, Ltd., a director of Strutt and Parker Farms, Ltd., a director of the Agricultural Mortgage Corporation, a member of council of the National Institute of Agricultural Botany, a trustee of the Lord Wandsworth Agricultural College, and an 'appointed' member of the executive of the Potato Marketing Board.

Bernhard Naunyn (1839-1925)

BERNHARD NAUNYN, an eminent German physician and experimental pathologist, was born on September 2, 1939, in Berlin, where he studied medicine under Lieberkühn, Reichert and Frerichs. He qualified in 1862, and after acting as clinical assistant to Frerichs for some years, became successively professor of medicine at Dorpat (1869–71), Bern (1871), Königsberg (1872–1888) and Strassburg (1888–1905). He was the author of two medical classics, the first on cholelithiasis (1892), which was translated into English by A. E. Garrod for the New Sydenham Society's publications (1896), and the second on diabetes mellitus (1898). He also wrote important articles on cerebral compression, the problem of fever, coagulation of the blood, gastric fermentation, cirrhosis of the liver, disorders of speech and syphilitic disease of the nervous system. Considerable historical interest is attached to his papers on "The Development of Internal Medicine in the Nineteenth Century", "The Berlin School 50 Years Ago" (1908), and his autobiography entitled "Erinnerungen, Gedanken und Meinungen". In 1872 he founded, in conjunction with Schmiedeberg, the *Archiv für experimentelle Pathologie und Pharmakologie*, and in 1896, with the surgeon Mickulicz, the *Mittheilungen aus den Grenzgebieten der Medizin und Chirurgie*. Naunyn had many pupils who attained distinction, such as Eichhorst, Minkowski, Schreiber, Stadelmann, Umber and Weintraud. He remained active in his retirement at Baden-Baden until shortly before his death, which took place on July 26, 1925.

Gift of Sutton Hoo Antiquities to the Nation

ALL anxiety, which has been not inconsiderable, as to the future of the antiquities from the Sutton Hoo Anglo-Saxon royal ship-burial has been allayed by the announcement made by the Trustees of the British Museum (Bloomsbury) that Mrs. E. M. Pretty, declared their owner by the verdict of the Coroner's inquest of August 14 (see NATURE of August 19, p. 318), has generously presented them to the Museum. The gift is subject to a condition that they shall be exhibited in due course on loan for a period in the Borough Museum of Ipswich. The gift comprises articles in gold, gems, and enamel, silver, bronze, iron, stone, wood, leather and textile fabrics—everything, in fact, which was found in the ship-burial on her estate at Sutton Hoo. Thus the relics from a find, which archæologically is the most important of its kind made in Great Britain, and the most valuable of its period made anywhere, not only become the property of the nation, but also will be preserved together as a whole. Had the collection been dispersed, as was feared possible, the discovery would have lost much of its unique value for cultural studies, and as tangible evidence for the whole complex of religious and social concepts, which inspired our Anglo-Saxon forbears in the seventh century of our era in their reactions to the demise of a chiefly head and representative of the community. Intrinsically valuable objects and jewels in gold, silver, and enamel, especially when found in such rich profusion, impress the popular imagination: they afford evidence of a highly developed æsthetic faculty and superb skill in technique; but it is the humbler objects with which they are associated, the personal and domestic articles of the less precious metals, the pottery, the wood, leather, stone and the textiles, which are the more eloquent for the student of the culture of the time. They are the raw material

from which the archæologist interprets advance in civilization and the cultural history of the people as a whole.

EXCAVATIONS are still proceeding on the site in the hope of securing further evidence, which will throw light on certain points still obscure. It would appear to be beyond doubt from the completeness of the funeral furniture, the extensive equipment, domestic and personal, and the unexampled richness and excellence in workmanship of the jewellery and objects in precious metal, that this was the burial-place of a king or chiefly leader, which is to be assigned, on the evidence of the Merovingian coins, though themselves bearing no date, to about A.D. 640; but as yet no evidence of identification has been found. Such suggestions as have been made are purely speculative. It is further remarkable that no skeleton, or fragments thereof, or evidence of cremation, have been found. It has been suggested as possible that the burial mound may have been intended to confer the last rites on a leader whose body had been lost at sea. Should further relics accrue, presumably they will be added to the original gift, with a generosity worthy of the owner. The verdict of the Coroner's inquest, however, has given rise to some serious misgivings as to the possibilities to which a find of this value, and in such circumstances, is exposed. It has been suggested that drastic measures should be taken by legislation to ensure their reservation to the nation. It is probable that any such action would defeat its own end. The generous interpretation of compensation now accepted in application of the law of treasure trove, which ensures to the finder the full archæological value of a find, and the vigilance of the Office of Works, are adequate to meet ordinary contingencies, while any exceptional find, such as that at Sutton Hoo, is certain of the protection of a publicity which would be intolerant of anything in the nature of improper disposal.

A Museum of the Roman Wall: An Appeal

WHILE some, at least, of the advantages of an adequate display for relics from the Roman Wall must be obvious to every layman who gives the matter a thought, only an archæologist can appreciate to the full both the hindrances to Romano-British studies of the present arrangements, as well as the benefits which would follow from the appropriate grouping of the collections in premises dedicated to this sole purpose. Mr. Ian A. Richmond, lecturer in Romano-British archæology in the University of Durham, in a review in *The Times* of August 29 of the present position, touches upon both aspects of the matter in putting forward a plea for better accommodation for at least some of the collections under the custody of the University of Durham. At present the relics from the Wall are divided between three principal museums, the Blackgate at Newcastle-upon-Tyne, Tullie House at Carlisle, and Chesters on the Wall itself. These museums are both overcrowded and ill-adapted to the requirements of modern display. In particular, the Blackgate, the medieval gateway of the Castle, is the most urgent problem. Once a debtors' prison, it is dark and gloomy, yet it contains the collections of the Society of Antiquaries of Newcastle-upon-Tyne, which now have been in existence for more than a century and are the most important source of information on the Wall and its area.

So strongly did the needs of the situation and the claims of Hadrian's Wall as "one of the universally famous monuments of our island" appeal to the Standing Commission on Museums and Galleries that it was from this body that the suggestion came that the responsibility of a museum of the Roman Wall should devolve upon the University of Durham; and following upon an expression of willingness by the Council of the Society of Antiquaries to transfer the custody of its collections to the University, and an appeal to the public by Lord Eustace Percy, as representing the University, for funds to erect such a museum, the University Grants Commission has generously made an offer of £5,000 towards the cost of the building, provided the balance of £15,000 required is raised within two years. Mr. Richmond goes on to point to a number of directions in which study of Romano-British culture is hampered through lack of adequate and appropriate display of the material.

Gloucester Museum

REFERENCE was made recently in the columns of NATURE (July 15, p. 91) to the origin of certain of the provincial museums as centres of intellectual and social exchange in days of less easy transport and communication. An example of a museum originating in this manner and of the function it is now able to fulfil in municipal life is afforded by the Public Museum of the City of Gloucester. This museum was founded in 1859 by members of the Gloucester Literary and Scientific Association (now dissolved) and the Cotteswold Naturalists Field Club. The collections were housed originally in two rooms lent by Mr. Sydney Dobell, but were removed to the Art School in 1872, and finally transferred to their present home in the Price Memorial Hall in 1900, having been handed over to the Corporation by deed in 1896. A scheme of reorganization has been completed recently and the occasion marked by the issue of a "Short Guide to the Collections", which includes, in addition to the collections in the Public Museum, those of the Folk Museum in Bishop Hooper's Lodgings, opened by Dr. R. E. Mortimer Wheeler in 1935. The Public Museum covers both natural science and archæology; and specimens are available for detailed examination by students and research workers in a reference room set aside for the purpose. The archæological specimens are in the main of local derivation, and are arranged to illustrate the development of the material culture of early man in the local environment down to Saxon times. Historical relics later than the Norman Conquest are to be found in the Folk Museum, which illustrates

the medieval and later economic and social life of the city and surrounding country in agriculture, trades—Gloucester is famous for its early iron-working—and the home. A special exhibit arranged for the jubilee conference of the Museums Association at Cheltenham in July had as its most prominent exhibit a selection of the local horn industry, which has existed in Gloucester since medieval times and still survives in one small factory.

Indian Association for the Cultivation of Science

THE annual report of the Committee of Management of the Indian Association for the Cultivation of Science for the year 1938 records a membership of 128 at the end of the year (Calcutta: Indian Association for the Cultivation of Science, 1939). Financial stringency has limited the purchase of reference books and periodicals for the library and also that of scientific apparatus, and for the same reason the Government of India has been unable to restore the ten per cent cut in the annual grant of 20,000 rupees for the year 1938-39. Appendixes include lists of periodicals available in the library and of books purchased as well as an account of research work carried out in the laboratories of the Association. An arrangement has been devised for magnetic measurements, at low temperatures in the range obtainable with liquid air, on typical paramagnetic salts of the rare earth and the iron group. Magnetic measurements on rhodochrosite, $MnCO_3$, indicate that this crystal should prove a more suitable substance than the hydrated sulphates and selenates of manganese for use as the medium for the production of very low temperatures by the demagnetization method. Other studies have included the magnetic anisotropy of hydrated gadolinium sulphate, crystalline fields in rare earth salts, magnetic studies in relation to valency problems and to crystal structure, magnetic studies on organic crystals of the aromatic class, and optical studies of the chrysene molecule. Other work has been concerned with the absorption spectra of arsenic and antimony sulphides and of the sulphur molecule.

Adult Education in Household Science

HOME-LIFE problems have become, under the impact of social and economic changes, increasingly complex and baffling, and among expedients employed in the United States for coping with the situation is the promotion of adult classes for home economics. Such classes are becoming increasingly important, and the Office of Education has issued a stimulating and helpful guide entitled "Homemaking Education Programs for Adults" (Washington, D.C.: Government Printing Office. Pp. 126. 15 cents). A detailed discussion of principles and methods of instruction appropriate for communities of different types and the preparation of teachers and leaders is followed by illustrations drawn from various parts of the United States. As an example of the scope of the work of the classes, here is a list of headings taken from a Kansas leaflet for use by itinerant teachers: food for the family, clothing, child-care and development, home-management, care of the sick, shopping, home-planning and furnishing, hospitality in the home. The extent and character of the existing provision for such classes vary widely in different parts of the country, but the discussion reveals the existence of an increasing emphasis in American theory and practice on the necessity for "the extension of educational activities beyond the confines of the school building into the community", involving acceptance by the public educational authorities of responsibility for provision of nursery schools and adult classes. The bulletin contains much that should interest household science schools, organizers of adult education and women's institutes.

Health Organisation of the League of Nations

THE annual report of the Health Organisation is contained in its recently issued *Bulletin* (8, Nos. 1–2, Allen and Unwin, Museum Street, W.C.1. 5*s*.). Prevention and treatment of malaria, cancer, leprosy, nutrition, housing and physical education, biological standardization and drug traffic are some of the subjects that are covered by the activities of the League's Health Organisation. A considerable report on rural housing and planning is contributed by M. Vignerot (France). The last article, of 260 pages, is a survey by Dr. Walch-Sorgdrager of Leptospiroses, diseases of man and animals caused by infection with minute spirilliform micro-organisms, which include infectious jaundice or Weil's disease of man and infectious jaundice of dogs. A recently differentiated epidemic disease of man, 'mud fever', is fully described. It occurs in regions of the Danube, Elbe and Oder which are liable to floods, though is not necessarily connected with flooded districts, and is caused by a species of Leptospira, *L. grippotyphosa*. The disease is an acute and severe febrile condition, but is never fatal. The natural habitat of this microbe is uncertain, as is also the problem of transmission to man. A bibliography of 70 pages completes this important article. A review designed to show how the Health Organisation functions, entitled "World Health and the League", is also issued by the League (Messrs. Allen and Unwin. 6*d*.).

Birth Customs in East Anglia

IN the June issue of *Folk-Lore*, Miss Barbara Newman and Mr. Leslie Newman record the result of a questionnaire sent to a large number of nurses in Norfolk, Suffolk, Essex and Cambridgeshire for information on husband's 'labour pains' and husband's pains other than labour, such as sympathetic morning sickness and toothache, the use of herbal remedies to ensure easy labour or to quicken labour, and customs connected with the placenta, umbilical cord and caul. Nearly all the midwives agreed that 'husband's pains' were quite usual. In one case a medical man had himself suffered therefrom, and had no doubt that in cases which had come under his observation the pains were both genuine and severe. As regards the prevalence of 'husband's toothache', it was reported that at a town council

(*Continued on p.* 437)

NATURE

SUPPLEMENT

Vol. 144 SATURDAY, SEPTEMBER 2, 1939 No. 3644

THE WESTERN ISLES THROUGH THE MISTS OF AGES

By Sir Albert C. Seward, F.R.S., President of the British Association*

Introductory

TWENTY-SEVEN years ago, when the British Association met for the second time in Dundee, Sir Edward Schäfer chose as the subject of his presidential address, "The Nature, Origin, and Maintenance of Life"; he discussed problems that will long continue to exercise the ingenuity and stimulate the imagination of biologists and chemists. A theme such as his is far beyond my reach. Seventy-two years ago, the Association met for the first time in this city. The Duke of Buccleuch occupied the presidential chair, and the opening words of his address are applicable to one who now finds himself in this privileged position. The Duke said: "No man has a title to state that he is unworthy of the post he is called on to fill, whatever may be his private feelings as to his fitness for the post. To state that he is unworthy to be there placed is not only a disparagement to himself, but is no great compliment to those who thought him worthy of being so placed".

This, in my opinion, is not an occasion on which it is desirable to follow the easier course and address oneself in technical language to fellow-workers in the pursuit of natural knowledge. The position which it is my great privilege to occupy affords a rare opportuntiy of talking to a large and, I venture to hope, a sympathetic audience, including some at least who are repelled by the jargon of specialists. My intention is to speak in ordinary language on a subject of which I know enough to realize how little that knowledge is, and briefly to describe an example of the way in which, within one small patch of an illimitable field, a student asks questions of Nature and does his best to interpret the answers.

An Excursion into the Past

I invite my audience to accompany me on an excursion of a kind which has substantially contributed to the enjoyment and enrichment of my own life, an excursion into a world that knew not man, with the object of deciphering from such records as we find in the rocks a few pages of the story-book of the earth. Each one of us can say with Shakespeare's soothsayer:

> "In Nature's infinite book of secrecy
> A little I can read."

As that great Scotsman, Hugh Miller, wrote nearly a century ago: "We find the present incomplete without the past—the recent without the extinct". To reinforce his own opinion he quoted Samuel Johnson: "Whatever makes the past, the distant, or the future predominate over the present advances us in the dignity of thinking beings". We shall try to reconstruct a small part of an ancient land, a remnant of which is now called Scotland, and envisage a scene at a stage in the history of the earth separated from the present by at least sixty million years, a stretch of time difficult for us who have been called "the afterthoughts of creation" fully to appreciate. When we substitute geological standards for the modest time-scale of the human period and remember that the earliest chapters of the world's history

* Presidential address delivered at Dundee on August 30.

are recorded in rocks at least two thousand million years old, sixty million years dwindle to comparative insignificance. All that it is possible to do is to lift a corner of the veil separating us from the world as it was and view through dimly illuminated vistas the forests and undergrowth on an ancient continent that is now represented by a few widely scattered, dismembered pieces.

The History of Plant Life

The history of plant life in the sea and on land is a branch of natural knowledge not unworthy of consideration by us human beings who owe our existence to the vegetable kingdom. Green plants in one vital sense are our superiors: from air and water they build up the complex organic substances necessary to our life, a feat beyond man's power. As members of a subject race we should be interested in endeavouring to unravel the history of the plant kingdom—in trying to trace the origin and relations of the several classes and groups as defined by botanists. The documents that are the sources of the botanical historian are contained in the earth's crust: as a preliminary it is worth while to ask ourselves of what these documents consist; how they came to be preserved in the rocks.

In order to bring to life the past we must take the present for our guide: "speak to the earth, and it shall teach thee". There is no reason to think of Nature's methods as other than continuous. If we stand by the bank of a river flowing past tree-covered slopes, we see on the sand and mud by the edge of the channel or floating on the stream, leaves, twigs, and seeds that are random samples of vegetation scattered by wind or shed from overhanging boughs, debris swept along with off-scourings from the rocks to be carried eventually to a delta or an estuary where the water-borne material comes to rest. Beds of old sands and mud, with included fragments of contemporary trees and other plants, exposed on the faces of cliffs and ravines, are layers of sediment that have been raised to a higher level. In addition to leaves, twigs and other scraps easy to see on the split surface of sandstone or shale, sediments of former ages, especially such as are peaty, occasionally furnish another valuable source of information invisible to the unaided eye. Minute grains of pollen may be carried by wind to places where conditions are favourable for their preservation: fortunately the grains, or at least most of them, are protected by highly resistant coats and retain almost for all time their characteristic form and surface-sculpturing. With scarcely any exception, it is possible for a specialist, by comparative microscopical examination of fresh material, to assign fossil pollen-grains to their generic and occasionally their specific position in the plant kingdom.

There is another natural agency to which students of extinct plants are not infrequently indebted—the formation of rocks by volcanic action. From time to time, volcanoes that have long been dormant eject clouds of ash: these, with streams of lava poured over the rim of a crater, spread havoc among trees and shrubs that had colonized precarious sites during a peaceful interlude. Vulcanicity is not only destructive: paradoxical as it may seem, forces inimical to life have contributed to the reconstruction of life which they destroyed. Scotland is exceptionally rich in botanical treasures that are legacies from ages of fire, and indeed the fossil plants with which we are concerned here owe their preservation to volcanic forces.

The following botanical retrospect is based mainly on results obtained during the last two or three years, but not yet published, by the joint efforts of Mr. W. N. Edwards, keeper of geology in the British Museum, Dr. J. B. Simpson of the Geological Survey, and myself.

Reconstruction of a Forest Scene

A. *The geological background:*

(i) *Prolonged and intermittent volcanic activity*

In order to present in true perspective the scene which it is my aim to bring to life, it will be helpful to visualize the physical features in north-western Europe some thousands of years antecedent to the phase of geological history chosen for closer examination. The chalk downs of England and part of the cliffs on the Antrim coast of Ireland are made of upraised calcareous material that was once a soft white ooze on the floor of a clear sea, a sea which had swept slowly and irresistibly over an enormous stretch of land, embracing the greater part of England, northern Ireland and part of the region that is now western Scotland. With the uplifting of the chalky ooze from the ocean bed and the gradual recession of the waters a new land was born; a new chapter was inaugurated in the history of the earth.

Following the great upheaval, as a consequential phenomenon, subterranean forces that had long been quiescent gained the upper hand: floods of semi-molten rock from deeply hidden reservoirs surged as a fiery deluge over the chalk downs, and

over other and older rocks, converting thousands of square miles into barren lava-fields, extending over an area, not less than 2,000 miles from south to north, which reached far beyond the Arctic Circle.

This unprecedented manifestation of volcanic energy, which is by no means confined to Europe and the arctic regions, but recorded on an equally titanic scale in the peninsula of India and elsewhere, is one of the wonders of geology; it is convincing evidence that the earth after the lapse of many hundred million years had not lost her youth; there was no sign of senescence. During the period we are considering, most of Britain was land: we know that at a slightly later date a broad sea lay over the whole of what is now southern England. Travellers in the tube-railway in the London district may perhaps derive pleasure from the knowledge that they are being conveyed through a stiff clay upraised from the floor of that ancient sea. As an appropriate designation for the great northern land an American geologist suggested the name Thulean continent or province (see map, p. 417). In the early days of the period called by geologists the Tertiary era, the greater part of the Thulean province was covered with sheets of sombre-coloured lava in nearly horizontal layers, products of a series of outbursts from deep fissures rent in the earth's crust under the compelling strain of subterranean forces, and from localized volcanic centres of eruption. The columnar basalts of the Giant's Causeway, the columns of the 'cathedral of the sea' at Fingal's Cave, the basalts of Mull, Skye, Canna, Eigg, and other Western Isles, weathered into step-like terraces, which form a characteristic feature of Hebridean cliffs, the flat-topped McLeod's Tables of Skye (1,600 ft.), precisely similar basaltic platforms on the hills of Disko Island and the mainland of western and eastern Greenland—all these are parts of one stupendous whole, a plateau covering half a million square miles, that was once the Thulean continent. The widespread lava-flows represent one phase of volcanic activity in an age of exceptional unrest.

Another phase is illustrated by more coarsely crystalline rocks such as those of the dark Cuillin hills of Skye: they were not poured out as lava-streams over the land, but were forced upwards as great dome-like masses from a deeply seated subterranean source and, as their coarser texture proves, slowly cooled under the pressure of a thick superincumbent load: the comparatively large size of the crystals indicates gradual solidification from a molten mass.

These two phases of prolonged rock-building help us to appreciate the immensity of geological time. Describing the lava-flows of Mull, Sir Archibald Geikie wrote: "On Ben More we can walk over each bed of basalt from the sea-level to the mountain top, a height of 3,169 ft." The basaltic lavas we see in the cliffs of Mull, and many other islands are but a part of the original pile: those that remain furnish an impressive example of rock construction which must have extended over an enormous period of time. The second phase, on the other hand, is an equally impressive example of rock destruction as a measure of geological time. We see the jagged peaks of mountains rising to a height of 3,000 ft. above sea-level which, at no distant date as earth history is reckoned, were buried under a considerable thickness of younger rocks that have been utterly destroyed by the ceaseless operation of denuding agents.

The world to our limited vision appears to be almost static; the mountains we have been accustomed to think of as symbols of eternity, seen through geological spectacles, take their place as episodes in a series of events which have moulded the changing features of the earth's face. The rocky covering of the world viewed by geologists, "foreshortened in the tract of time", reveals itself as a dynamic, mobile crust responding from age to age to constructive and destructive forces which have operated since the earth's early youth, following a still earlier stage when, in the imagery of the poet,

"This world was once a fluid haze of light."

(ii) *Plant-bearing sediments indicative of quiescent intervals*

So far the events chronicled in rocks of igneous origin have been spoken of as though there had been continuous outpourings of lava with occasional showers of ash and, in some districts, upwelling of molten material that remained hidden below the surface until in the course of time the covering rocks were removed by erosion. There is, however, clear proof that the extrusion of lava and other rocks was intermittent: intercalated among the lava-beds are layers of sedimentary material, hardened sand and mud, layers of coal, and beds of fine-grained limestone containing beautifully preserved leaves, a few fruits and other plant fragments, also rare examples of insect wings and shells. The richest plant-containing layers occur

near the base of the pile of basaltic lavas on Ardtun Head, the low 'headland of the waves' near the south-western corner of Mull, the island on which from his home on Iona—which has been aptly named 'the light of the western world'—Saint Columba must often have gazed. Trees, shrubs, and other plants were able to colonize portions of the lava-field during the long pauses between recurrent outbursts of volcanic fires.

The association of sedimentary material with the basalts at Ardtun Head was noticed by Abraham Mills so long ago as 1790; but it was not until the middle of the nineteenth century that Mr. McQuarrie of Bunessan discovered the fossil plants, which were very briefly described by Prof. Edward Forbes in an appendix to an important paper by the Duke of Argyll published by the Geological Society of London in 1851. The Duke spoke of the leaves as having been shed "autumn after autumn into the smooth still waters of some shallow lake, on whose muddy bottom they were accumulated, one above the other, fully expanded and at perfect rest". By far the richest collection of fossils was made by Mr. Starkie Gardner rather more than fifty years ago, and partially described by him in a paper read to the Geological Society of London in 1887. Descriptions of several fossil plants from the Mull beds have also been published by Dr. T. Johnson. The main collection is now in the British Museum. Additional specimens have been obtained by other collectors in more recent years.

The work of deciphering the botanical records from Mull, Skye, and a few of the other islands is rendered mildly exciting by the danger of misinterpretation: fossil leaves, we are often reminded, are very uncertain guides—records left by Nature in a mischievous mood to mislead the unwary and overconfident student. Sir Joseph Hooker, in an address to the British Association at Norwich in 1868, spoke of fossil botany as "this most unreliable of sciences"; but he added by way of consolation—"the science has of late made sure and steady progress, and developed really grand results". One may cheerfully take the risk of being called an unscientific optimist by colleagues whose chief concern is with living plants. Botanists who confine their attention to recent plants have ample sources of information, not merely detached leaves but twigs bearing leaves, flowers, and fruits: it is natural, therefore, that they should tend to under-estimate the value of leaf-form and venation, often the only criteria available to the palæobotanist.

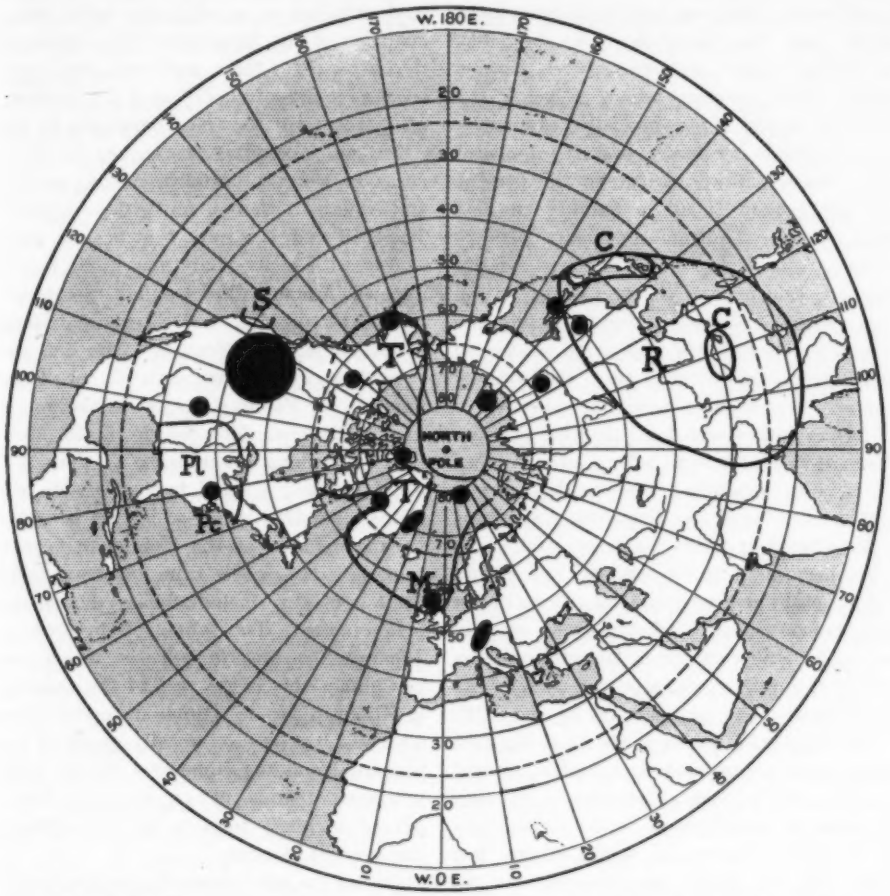
B. *The ancient flora of the Inner Hebrides.*

What then is it possible to say about the ancient flora of the Inner Hebrides without transgressing the limits of probability? We know very little of the smaller and simpler plants which lived under the shade of the forest trees or clung to the surface of stems where they were washed by trickling rills of rain-water. The three smallest plants which have left recognizable fragments are a fungus and two liverworts or, as they are often called, hepatics, a group allied to the mosses but of simpler construction. The fungus was found by Mr. Edwards several years ago on some detached leaves of a conifer from the Mull plant-beds; the manner of its discovery illustrates an interesting technique often employed with success by students of fossil plants. In many instances leaves preserved on shale are covered with a very thin, black coaly film produced as the result of chemical change in the plant tissues after death. It is often possible, by detaching a piece of the film and treating it with certain clearing agents, to remove the carbonaceous matter and obtain a sample of the surface skin of the leaf that is brown in colour, transparent, and suitable for microscopical examination. After treatment, the Mull leaves showed some minute dark spots on the surface film, and these on magnification were found to be circular disks made of rows of radially disposed cells. The disks were identified as organs of a fungus closely resembling reproductive structures of a living genus Phragmothyrium, a fungus now mainly tropical: the occurrence in Mull of a nearly allied form is, however, probably indicative of a moist rather than a tropical climate. One of the liverworts bears a close resemblance to a living species, *Pellia epiphylla*, which has a wide geographical distribution and is very common on damp earth in Britain; it has a flat green, forked body barely an inch in length. The other hepatic is a member of a different family, characterized by a slender thread-like stem bearing two rows of minute leaves; it bears a striking resemblance to some living species included in the order Jungermanniales.

These fragmentary remains of liverworts are worth mentioning because fossil examples of such plants are comparatively rare; also for a more important reason. A few years ago Prof. J. Walton of Glasgow published a description of some liverworts discovered for the first time in rocks containing remains of plants which grew in the forests of the Coal Age about 200 million years ago. The interesting fact is this:

the Palæozoic liverworts differ scarcely at all in the construction of the delicate plant-body from the much later forms from the Thulean continent: geological periods with practically no modification of their simple design.

The only fern so far discovered is very nearly



MAP OF THE NORTHERN HEMISPHERE ILLUSTRATING SOME OF THE SUBJECTS DEALT WITH.

C, C. The present geographical distribution of Cercidiphyllum, a Japanese and Chinese tree. Black patches mark localities and districts where fossil specimens of Cercidiphyllum have been found. Arctic and sub-arctic regions: Alaska, Mackenzie River, Grinnell Land and Ellesmere Land, West and East Greenland, Spitsbergen, New Siberian Islands, Lena River. Canada and the United States of America: several localities from British Columbia and California, and east of the Rocky Mountains in Montana, Wyoming, Oklahoma, etc. The oldest examples of Cercidiphyllum leaves are from early Cretaceous rocks in Maryland—the Potomac formation (*Pc*). Others are recorded from Europe—Mull, Switzerland, Bohemia, Silesia; Eastern Asia; Sakhalin Island and the Bureja River.

M. Mull and neighbouring islands.

Pl. The geographical distribution of the occidental plane.

R. Approximate boundary of the area within which are the present homes of the majority of trees and shrubs most closely related to extinct species of the Hebridean flora.

S. The present distribution of *Sequoia sempervirens* (redwood) and *Sequoia gigantea* (mammoth tree).

T. Hypothetical boundaries of the Thulean province.

both are essentially modern and yet both are surprisingly ancient. We do not know much about the history of these plants, but it is clear that some liverworts persisted through a succession of related to the sensitive fern, *Onoclea sensibilis*, a familiar species in North America, ranging from Florida to Newfoundland and as far west as Saskatchewan; it occurs also in northern China,

Manchuria, Japan, and Corea: it has what is called a discontinuous geographical distribution. Onoclea, no longer a native of Europe, is often cultivated. The fossil fronds from Mull, both sterile and fertile, differ scarcely at all from those of the living fern. Records of the rocks show that Onoclea formerly grew in north-western Europe and in Greenland, regions where, through the vicissitudes of climate, it long ago failed to survive. Evidence furnished by fossils and the facts of geological history affords a clue to the present discontinuous range: in all probability Onoclea originated on the Thulean continent, perhaps north of the Arctic Circle, whence it spread radially into America, Europe, and the Far East; in the European region it became extinct, sharing the fate of many other plants that were unable to survive the rigours of the Ice Age. Its territory was originally continuous; now it is restricted to North America and eastern Asia. Another member of the class to which the ferns belong is the familiar Equisetum, the horsetails: one species, closely comparable with the living *Equisetum limosum*—widely distributed in north temperate and arctic lands—has been found in the sediments of Ardtun Head. Equisetum may be described as an emblem of changelessness: nearly related forms grew in Palæozoic forests at least 150 or 200 million years ago: less closely related plants in the same forests—the calamites—were comparable in size with trees. The slender horsetails of the Coal Age and their much more robust and woody allies remind us that in the course of evolution some of Nature's early experiments survived unaffected by the production of new competitors, while others, less successful, left no direct descendants. As we follow the march of plant-life through the ages, evidence of progress accompanied by retrogression becomes recurrently apparent: in the varying green mantle of the earth there can be traced threads running through the whole, changing very slightly as we follow them onwards and upwards, preserving all the time a remarkable uniformity in essential characters.

By far the greater number of the fossils from Ardtun are leaves of trees or shrubs which belong to one or other of the two great classes of seed-bearing plants. In Gymnosperms, including conifers and some other less familiar plants, the seeds are naked. In members of the other class, the highest, the most various and most abundant in the vegetable kingdom, the seeds are more efficiently protected and are contained in a closed case; hence the name Angiosperms. Conifers played a prominent part in the Hebridean forests, but their representatives were not such as we find in modern Europe. A single and well-preserved seed attached to a relatively large wing affords evidence of the occurrence of a conifer allied to the silver fir (*Abies pectinata*) and some other species commonly cultivated in Britain. Firs, using the term for trees belonging to the genus Abies, and excluding the spruce fir (Picea), now occur in Europe, northern Africa, northern Asia and America: there is no British species of Abies. The Mull seed, it is important to note, agrees most closely with seeds of firs now living in China and Japan. Among other conifers discovered in the plant-beds of Mull and Skye are Cephalotaxus, Cryptomeria, and Sequoia. Recent species of Cephalotaxus are comparatively small trees confined to the Far East; some kinds are cultivated in our gardens. The foliage of the Mull species bears a striking resemblance to that of *Cephalotaxus fortunei*, a small tree widely distributed in China. Another genus which we believe to have been a member of the Hebridean flora is Cryptomeria: the fossils from northern Ireland and the Isle of Skye include foliage shoots, cones, and pollen-grains. The solitary living species is the Japanese *Cryptomeria japonica*, which occurs also in China: this is the tree of the famous avenue of Nikko in Japan, a noble memorial of a peasant who was too poor in worldly goods to contribute the usual building stone or a bronze lamp to the mortuary temple of an emperor, and instead offered to plant trees to protect visitors against the heat of the sun.

One of the most interesting of all living conifers is the genus Sequoia, of which there are two species confined within the narrow strip of hill ranges bordering Oregon and California on the Pacific coast—the redwoods (*Sequoia sempervirens*) of the Coast Range, watered in the dry season by mists from the western ocean, and the mammoth trees (*Sequoia gigantea*, often called Wellingtonia) of the Sierra Nevada. (See map, *S.*) Sequoia is an impressive example of the light thrown by fossil plants on the past history and wanderings over broad regions of the earth's surface of trees that, without man's protection, would be in danger of extinction. In earlier periods Sequoia was almost cosmopolitan; it ranged over wide spaces in the Old and the New World and overstepped the limits of the northern hemisphere. Foliage shoots preserved in the sediments of Mull

were in all probability borne by trees closely related to the living redwoods, trees which are well worthy of inclusion among the wonders of the world; they attain a height of more than 300 ft. and the rings on cross-sections of giant trunks that have been felled bear witness to an age of 3,000 years and more. They were growing where they stand to-day 1,000 years before the Christian era. Trees next of kin to the redwoods once lived within a short distance from the Polar Sea several hundred miles farther north than the present tree-limit. Another species of Sequoia, more nearly allied to the mammoth tree, lingered on in Britain long after the disappearance of the Thulean forests: this we know from the discovery of fossil twigs and cones in the sediments of an old lake on the edge of Dartmoor in Devonshire. The two surviving species live in splendid isolation, dreaming of a greater glory that was theirs, their memories stored with secrets man can never know.

There was another naked-seeded tree in the forests into which we have intruded, a species of Ginkgo, the maidenhair tree. The barbarous name 'Ginkgo', invented in 1712 by the German naturalist Kaempfer, is in the opinion of the Rev. Dr. Moule, formerly professor of Chinese at Cambridge, a false transcription of 'sankyo', which probably means hill-apricot. Leaves perfect in form and venation were found in the chalky sediment of a lake that filled a hollow in the Hebridean lava-field; they differ from the foliage of the living tree only in a few minor features detected by the practised eyes of Dr. Florin of Stockholm in the microscopical structure of the superficial cells. Dr. Simpson discovered Ginkgo pollen-grains at another locality. The story of the maidenhair tree has recently been told (*Science Progress*, January 1938), and the temptation to linger over it here must be resisted.

Ginkgo of all trees furnishes the most thrilling example of a link with the past; its history, compiled from fossils of many geological ages and in many parts of the world, is an enthralling romance. This is but one of many histories recorded in Nature's story-book which makes us share the thought of Edward Fitzgerald: "Yes, as I often think, it is not the poetical imagination but bare science that every day more and more unrolls a greater epic than the Iliad". It would be rash definitely to assert that the maidenhair tree still exists under strictly natural conditions as a wild tree of the forest. Botanists who have searched for it in China, the country believed to be its last home, failed to discover convincing evidence of the occurrence of specimens which could not be ascribed to man's agency. On the other hand, a few years ago a Chinese botanist expressed the opinion that Ginkgo still grows wild in the province of Chekiang in eastern China. The oldest living examples occur in China and Japan, often in places where, as is fitting, they are venerated as trees endowed with healing properties.

The history of Ginkgo has been traced to periods antedating by millions of years the Thulean forests: we do not know of what sort its progenitors were; but we know that it is a survival from an age too remote for us to measure in terms which we can fully appreciate. We also know that Ginkgo, now a lonely relic in the present world, is a primitive and isolated type, the sole representative of a large family, including many different members, all of which save the maidenhair tree long ago fell by the way in the struggle for existence. When the tree lived in the Hebridean forests it was common in other parts of the Thulean continent from northern Canada to Greenland and Spitsbergen, in North America, Europe, and Asia. It was as widely distributed geographically as oaks, pines, and firs in the modern world. The history of Ginkgo is a record of endurance, of persistence with apparently little change in an unstable world. When we recall the amazing life-story of the tree and its forbears the autumnal colour acquires a deeper significance: we see in the pale yellow of the leaves a reflection of the golden age of a family that left a precious legacy. Would that the maidenhair tree were endowed with the oracular power of the oaks of Dodona and, in the trembling accents of its fluttering leaves, could tell us not of the future but of the varying fortunes of the family as age succeeded age.

The Ginkgo of Mull was not the last of its race in Europe: well-preserved remains have been found in younger rocks in France and Germany, proving that it survived in the Western world, though probably only in a few places, to an age preceding by a comparatively short period the invasion of temperate Europe and North America by arctic ice-sheets and glaciers, which had a far-reaching effect upon the vegetation in the Western world.

Leaving the naked-seeded plants, we pass to the flowering plants or Angiosperms. This class is more recent in origin than the Gymnosperms, at least so it would seem, and as in present-day floras

so also in the Thulean forests, flowering plants contributed the greatest number of genera and species. We shall take first a few trees and shrubs which have descendants still living in Europe, and afterwards mention others that have no near relations in European floras. There were, we think, three or four kinds of oak, all different from those now living in Europe and America. The largest leaves from Mull assigned to the genus Quercus are oval, with a broadly rounded base and relatively small teeth; they resemble the foliage of a few Indian species, but the oak with leaves most closely resembling the fossil form is *Quercus serrata*, a native of China, the rain-forests of Assam, Japan, Korea, and the Himalayas. A second species from Mull is closely comparable with other Indian and Far Eastern oaks; and a third form of leaf is very similar in shape and venation to a species that now has its home in China, Assam, and the island of Formosa. It is noteworthy that none of the oaks of the Thulean forests conformed in pattern of the foliage to our familiar British trees.

One of the most conspicuous trees in the Hebridean woodland was a plane (Platanus) with large handsome leaves almost, but not quite, identical with those of the existing occidental plane of North America. The fossil evidence in this instance is supplied by male flowers and fruit-balls as well as leaves. As in all living planes, the expanded base of the leaf-stalk enclosed and protected a bud. There is, however, one interesting feature in which the leaves of the Mull tree differ from those of any living plane: there were two fairly large leaflets attached to the long leaf-stalk between the main part of the leaf and the base of the stalk. The significance of this peculiarity need not be discussed; it is one of those botanical problems of academic interest which excite the specialist. A more important fact for us is that plane trees in the period we are considering occupied a territory which extended very much farther north than the present area of distribution. Remains of plane trees have been found as far north as Spitsbergen in rocks approximately equivalent in age to those of Mull.

There are in the world to-day six or possibly eight different kinds of plane: the oriental plane (*Platanus orientalis*), the only species native in Europe, is one of the noblest living trees; it recalls the groves of the Academy in the golden age of Greece. One of the oldest specimens is the venerable stump bearing enormous arms in the market place on the island of Cos where, legend would have us believe, Hippocrates, more than two thousand years ago, gave advice to his patients under the shade of the youthful tree. The oriental plane extends from Greece and the Aegean islands eastward to Asia Minor and the Caspian Sea; it is sometimes said to be wild in Persia and northern India, but more probably this eastward spread should be attributed to man. The most widely distributed species in the New World is *Platanus occidentalis*, growing usually in river valleys from Lake Ontario to Florida and west to Texas and Nebraska (see map, *p.* 417, *Pl*). On the western side of North America there are other species, in Mexico and along the Coast Range hills of California. The most familiar cultivated species in Britain is *Platanus acerifolia*, the so-called London plane: this favourite urban tree is regarded by some botanists as a hybrid between the oriental and the occidental plane; the time and place of its origin are not known with any certainty.

The geological record of Platanus affords a striking example of contrasts between past and present areas of distribution. Some of the oldest known fossil leaves and fruits are from early Cretaceous beds in Greenland, at least 300 miles north of the Arctic Circle. The occurrence of these remains, in sediments that were deposited in a remote northerly estuary before the chalk of the British Isles had been upraised from the sea-floor, affords definite proof that plane trees lived in arctic forests millions of years before they spread to the southern part of the Thulean continent. The birthplace of Platanus may have been in the far north, whence in course of time it spread to Iceland and Spitsbergen, from arctic to temperate North America and Europe, and wandered as far east as Sakhalin Island on the eastern confines of Asia.

One of the comparatively few trees in the Hebridean forests related to recent British species was a Corylus with leaves similar to those of our hazel but still more like the foliage of species now living in India and the Far East. Hazels were associated with planes not only in the ancient flora of Mull but also in circumpolar forests from which they travelled, in response to the urge of climatic change, to fresh and more genial homes farther south. Another tree in the Thulean forests was a cornel, a species of genus Cornus, which has a far-flung distribution, in arctic and sub-arctic countries, in North America, Europe, and Asia. While fully conscious of the danger of placing excessive

trust in leaves as evidence of affinity, we believe that a Chinese cornel (*Cornus chinensis*) agrees most closely in foliage with the Mull species. The cornels are members of an old stock represented in northern forests as long ago as the Cretaceous period.

Among the larger fossils from Ardtun Head are a few almost perfectly preserved leaves of a vine, which we believe to be specifically identical with specimens previously discovered in Alaskan rocks of approximately the same geological age as those associated with the lava-flows of Mull. Similar leaves have been described from Greenland, Iceland, Spitsbergen and more southern localities in America and Europe. Vines were widely distributed even as far back as the Cretaceous period: there is now only one European species, the wine-producing *Vitis vinifera*; but its leaves are unlike the fossils from Ardtun. The striking contrast between the present distribution of the vine in Europe and its former, much more extended distribution which included arctic and north temperate regions, raises the difficult problem of changes in climate from one age to another. Vine scrolls are a fairly common ornament on early Northumbrian Anglo-Saxon crosses, a motif adopted in still earlier ages by Greek and Roman sculptors, which, after the lapse of centuries, reached the highest expression of naturalistic treatment in England in the last two decades of the thirteenth century. Millions of years before vine leaves and fruit were fashioned in stone, one kind lived in pre-human days on the Thulean continent; and it is noteworthy that its nearest counterpart in the modern world occurs in the Far East.

We turn now to trees and shrubs belonging to genera which are no longer living in Europe. The first tree to be considered furnishes a striking contrast, in the narrow limits of its present geographical area, to the widely spread cornels and oaks. Cercidiphyllum is now confined to Japan and mountain valleys in some parts of China (see map, *C,C.*). The name Cercidiphyllum was chosen because of a superficial resemblance of the leaves to those of the Judas tree, *Cercis siliquastrum*; only a single species, with a few varieties, has survived, *Cercidiphyllum japonicum*, familiar to many tree lovers who cultivate it for the sake of the exceptionally beautiful gold, pink, and red parti-coloured autumnal foliage. In common with some other trees of ancient lineage, Cercidiphyllum lacks any near relations in the present age; it is one of a select company of Nature's anachronisms. Like the Maidenhair tree, it is an aberrant type, a relic living within a comparatively small area in the Far East: formerly it was one of the most widely distributed forest trees on both sides of the Atlantic Ocean. Several beautifully preserved leaves have been found in the plant-beds of Ardtun Head, leaves and occasionally fruits of Cercidiphyllum have been found in Grinnell Land and Ellesmere Land on the north-eastern corner of the Canadian Archipelago, in Alaska and at several localities on the Pacific and Atlantic coasts of North America, in Greenland, Iceland, and Spitsbergen, as well as in Switzerland and other parts of Europe (see map). Leaves, superficially at least indistinguishable from those of the existing species, are recorded from sedimentary beds in the valley of the Potamac River in Maryland assigned to the early days of the Cretaceous period when flowering plants were comparatively few in number and had not yet come into their own as the dominant class in the plant kingdom. When we remember the remote antiquity of Cercidiphyllum and its wanderings over the earth's surface during the passing of millennia, the autumnal glory of its foliage is enhanced a hundredfold and acquires a symbolic meaning.

The plant-beds on the headland of Ardtun have yielded very few recognizable fruits and seeds. Among the rare examples of fruits are some, about half an inch long, consisting of a slightly elongated seed-vessel surmounted usually by five leaflets, the enlarged and persistent covering of the young flowers, which served as efficient aids to dispersal by wind. The fossil winged fruits and associated leaves present a remarkably close resemblance to those of some living species of Abelia, a genus named after Mr. Clarke Abel, who discovered the shrub in China about one hundred and twenty years ago. Abelia is a member of the honeysuckle family (Caprifoliaceæ): most of the existing species have their home in Central China and are cultivated as flowering shrubs in European gardens. There are a few species in Japan, the Himalayas, and Mexico. Fruits of a Chinese Abelia agree most closely with the fossil specimens. Similar though not specifically identical fruits were discovered thirteen years ago by Mrs. Clement Reid and Miss Chandler in a collection of fossil plants from Bembridge in the Isle of Wight. The Bembridge flora is younger geologically than the flora of Mull and indicates a warmer

climate. Other examples were recorded long ago from south-eastern France. It is therefore clear that shrubs next of kin to Abelias now living in China were once native in western and northern Europe. The introduction to British and Continental gardens in our time of Abelia, Cercidiphyllum, and other trees and flowering shrubs may be described as the reinstatement, through man's desire for horticultural novelties, of plants that had long been exiles from Western woodlands, where as natives they were never seen by human eyes.

So far, attention has been confined to a selection of plants identified from leaves and a few fruits. If time permitted, the list could be substantially enlarged by inclusion of the interesting results of Dr. Simpson's intensive study of pollen-grains, which he found by microscopical examination of broken-up pieces of lignite and coal, associated with sandy beds in Mull and on the adjacent peninsula of Morven. The pollen-bearing layers of rock are below the basaltic lavas and therefore slightly older than the leaf-beds of Ardtun Head. Dr. Simpson discovered several conifers and flowering plants confirmatory of identifications based on leaves; he also made many additions to the list compiled from leaves, fruits, and seeds. Three of his discoveries are selected for brief reference. He found pollen-grains of two kinds of alder (Alnus): the pollen of alders has a very characteristic structure and can easily be recognized. The occurrence of alders in the Hebridean flora supplies one of the few links between the extinct and the present European vegetation. The second genus chosen from Dr. Simpson's list is Magnolia: it is now represented by many species, both trees and shrubs, and is widely distributed on two sides of the Pacific Ocean: in Asia along the Himalayas and in parts of Tibet, over a large area in China, Japan and Korea, the Malay Archipelago, and Indo-China; in America from southern Ontario as far south as Central America and Cuba. It was shown many years ago that Mangolia formerly lived in Europe and flourished as far north as lat. 70° N. in Greenland; we now know that it played a part in the adornment of the Thulean forests.

Finally, a few words on the discovery of pollen-grains believed to belong to a species of Nelumbium: this genus is one of the most attractive water plants, a plant held sacred in ancient Egypt and venerated in the Far East. One of the living species is the sacred lotus, native in China and Japan and established as far west as the Caspian Sea; the other species has an extended range in North America, spreading as far south as the West Indies and Brazil. Nelumbium no longer grows in the Nile: long years ago it had a wide distribution in Europe, both in the Cretaceous period and in later ages. Looking backwards, we see its great circular leaves spread over the still waters of a Thulean lake.

It is important to note that Dr. Simpson's comparative investigation of fossil and recent pollen shows a preponderance of eastern Asiatic species in the Hebridean flora.

Fancy with Fact

We have attempted to re-create a scene in the past, and it is natural to ask—how does our reconstruction compare with reality? As it is impossible to satisfy curiosity by an actual flight to the Thulean continent, we can at least imagine ourselves miraculously transported to a destination where the past has become the present. At a very early stage of the backward journey we should see the greater part of the land being gradually obliterated by a covering of snow and ice; glacial conditions would be succeeded by a climate becoming more and more genial. Human beings would be missed before one-fiftieth of the flight had been completed. At last, after observing the moving panorama of land and sea, fluctuations in climate and changes in the character of the vegetation, let us imagine ourselves at the journey's end. Combining fact with fancy, we find ourselves, where in day-dreams we have often been, among the plants on the lava plateau. Thanks to the artistic co-operation of Mrs. Gwendy Caröe, it has been possible to give substance to our mental picture based on geological and botanical facts. It requires a special effort for us, who think of ourselves as overlords in Nature's realm, to visualize a world in which man has no place. Alone in a world which for millions of years to come would be uninhabited by the human race, we could scarcely fail to look upon the beauty of Nature's pageantry with a strange and more penetrating vision:

"Beauty, the eternal Spouse of the Wisdom of God and Angel of his Presence thru' all creation."

We should realize as never before man's insignificance: on the other hand, our estimate of spiritual values would be raised to a higher level and we should experience a deeper sense of union

with the infinite. Our tendency is to think of the past, as we think of the present—in relation to man; we forget his very recent participation as an actor in life's drama. As we look at Nature as into a mirror, our own image obtrudes itself into the foreground. Had man been a dweller on the Thulean continent he would have seen, as we see, the sun by day setting in motion the living machinery of trees and herbs; the splendour of the evening sky; he would hear the wind in the trees, the music of running water and the songs of birds. The beauty of Nature is eternal. To the east and north beyond the lava-fields the Caledonian mountain ranges would be seen rising to greater heights than any of their peaks reach to-day; they were still to be exposed for millions of years to the destructive operation of Nature's sculpturing tools. Making a fresh demand upon our imagination, let us take a longer view over the curve of the earth towards the heart of Europe and far to the east to northern India. We should look in vain for the Pyrenees, the Alps, the Carpathians, and the Himalayas: these and other mountain ranges had not yet been lifted up; the time of their birth was not far off. We should see in their place a broad belt of water stretching from the Atlantic to the Indian Ocean, linking West with East. On the bed of this ancient sea—the Tethys Sea of geologists—sediments had long been accumulating, and these, with other rocks of igneous origin, would be involved at no distant date in a complete transformation of the earth's features and the crumpling of the crust into the "everlasting hills".

Returning to the Thulean continent at a place near the present geographical position of the Inner Hebrides, let us take a survey of the vegetation. We should be impressed by its luxuriance: at first sight the general aspect would seem familiar, but on closer examination of the trees and shrubs we should find only a few recalling modern European species; many would remind us of exotic plants of Eastern origin. Despite the immensity of the time interval separating us from the world we had left, we should not be aware of any such marked contrast in the general character of the vegetation as we might have expected. The plants had already put on their familiar dress and would seem to us surprisingly modern. But—and this would be the deepest impression—we should feel that we were among trees and shrubs that were reminiscent of remote Eastern forests. We should be conscious of the dynamic character of the plant-world; we should be driven to the conclusion that the forests were mainly composed of wanderers resting for a time in a temporary home whence, as conditions changed, they would pass to other stages in the long journey to their present refuges in Asia.

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Evolution

There remains another question which is always asked by those who attempt to reconstruct the vegetation of past ages: What contributions do the records of plant-life make towards a better understanding of evolution? The riddle of evolution remains a challenge and, as knowledge increases, we make fresh guesses. As a Cambridge friend writes in a recent volume of "Provocative Verse":

> "That life evolves was guessed of yore,
> Darwinians prove it true;
> Of how and why we know but little more
> Than old Lucretius knew."

The little more we know urges us to continue in hopeful expectancy the long and endless prying into Nature's methods. What then do we learn from the ancient flora of the Western Isles?

The facts do not substantially help us to trace the unfolding of life in the long interval separating the older part of the Tertiary era from the present time. There is little difference between the past and the present vegetation of the world as a whole in the nature of trees, shrubs and ferns: our knowledge of the earlier history of herbaceous plants is very meagre. The fossil flora of Mull represents an early phase of what may be called the modern type of vegetation, which overspread the world in the later stages of the Cretaceous period and has persisted with few major modifications until now. Evolution seems to have been characterized by bursts of production when new and successful types exercised a transforming influence; and these periods of exceptional creative activity were separated by periods of relative stability. The early Tertiary floras belong to a stage when a new order had become well established and an older order had passed its prime. The one great difference that emerges from comparison of the Mull flora and the existing European floras is not a difference in the components of the world forests, but a contrast in the geographical positions occupied by the various genera in the northern hemisphere: for the most part a Western home has been exchanged for a home in the Far East.

Drifting Continents

If we followed the vegetation on the southern part of the Thulean land farther to the north, we should be impressed by its apparent indifference to changing physical conditions as we travelled beyond the Arctic Circle; we should fail to notice any zonal distinguishing characters in the floras such as in our day reflect the passage from temperate to arctic regions. The evidence of fossil plants forces us to the conclusion that the vegetation on the Thulean continent, its northern boundary within a short distance of the polar sea, its southern border on the latitude of northern Ireland and western Scotland, was astonishingly uniform. How, we ask, can we explain this surprising and well-attested fact? There must, it is generally agreed, always have been climatic belts; high arctic and much lower temperate regions cannot have supported closely comparable floras possessing several species in common. Some of us are convinced that changes in geography from one period to another, land connexions where there are now arms of the sea, interference with paths of ocean currents and consequential changes in temperature are inadequate as explanatory causes. What then remains? Were it possible for us to make a survey of the Thulean continent as it was, we might find that the geographical relation of the northern part of the forest-clad land to the North Pole was by no means the same as it is now.

It is difficult, it is probably impossible, to explain the facts without calling to our aid the hypothesis of drifting continents usually associated with the late Prof. Wegener and recently discussed in an able book by Prof. A. L. du Toit of South Africa. This is a controversial subject beyond the scope of my address: I can do little more than reaffirm adherence to the view that plant records from rocks of many ages raise problems which seem to be insoluble unless we postulate movement and sliding of the earth's crust. As icebergs are slowly drifted by ocean currents, as masses of cumulus clouds rapidly changing shape pass across a blue sky; so, the rate of travel enormously reduced, large slabs of the outermost rocky shell of the world may have shifted their position in the course of geological time. It must, however, be admitted that as yet refined methods of measurement have not furnished any evidence of crustal movement. Dr. Nörlund of Copenhagen has stated that longitudinal determinations, carried out by the Danish Geodetic Institute in 1927 and 1936 with a modern transit instrument, both times on the same pillar at a locality on the west coast of Greenland, gave practically the same result. In his presidential address at the Norwich meeting of the Association in 1935, Prof. W. W. Watts made an interesting and judicial reference to the Wegener hypothesis: he spoke of it as having been hailed by many classes of investigators as almost a panacea, and quoted one of several critics who called it a beautiful dream, the dream of a great poet.

Proof or disproof of the Wegener hypothesis will be forthcoming in the more distant future, when the precision of modern methods of measurement has been available long enough to provide trustworthy data. Meanwhile, we must be content to wait in sanguine expectation that an interpretation of the overwhelming evidence furnished by fossil plants will be provided by research workers in the geophysical field.

One of the most impressive examples of the bearing of fossil plants upon the fascinating problem of climatic conditions in the past has been furnished by Prof. T. M. Harris of Reading. The facts are briefly these: several years ago Prof. Nathorst of Stockholm described a large collection of fossil plants from rocks in Scania, the southernmost province of Sweden, demonstrating the existence of a flora many million years older than the one we have been considering. It was a very rich flora composed of numerous ferns, conifers, and other plants; it probably lacked flowering plants. More recently, Prof. Harris made a still larger collection of fossils during a long visit to eastern Greenland in the ice-bound district of Scoresby Sound where, under extreme arctic conditions, only a few stunted plants are able to exist.

Nothing could be more striking than the present contrast between the floras of eastern Greenland and southern Sweden. The arctic fossil plants of the same age as those from Scania demonstrate the former existence of a flora even richer than that from southern Sweden: comparison of the two floras affords no indication of any difference in the size of individual plants and no difference in the vegetation as a whole. A luxuriant and uniform vegetation occupied an area stretching from central Germany to southern Sweden and a thousand miles farther north beyond latitude 70° N. The fossils preserved in rocks at localities within this far-flung geographical area from south to north give no indication of any such change

in the plant communities as we should expect and as we find when we contrast arctic and temperate floras in the present world. This uniformity, I venture to think, is inexplicable unless we assume a very considerable movement and reshuffling of the earth's crust. The geological historian needs the co-operation of astronomers and physicists in his endeavour to reconstruct the world at the successive stages of its development; he looks to them to prevent him from making assumptions inconsistent with conclusions reached by workers in other fields. On the other hand, geologists and palæontologists contribute facts that are incontrovertible however much they seem to be in opposition to the views of students whose primary interest is in geophysical problems.

Neglect of Earth History in Education

There are still some people who ask, what is the use of the kind of information given in this address? My reply is that knowledge gained from a first-hand study of Nature, both animate and inanimate, has a value beyond price. Enjoyment of the romance of creation as recorded in the life of the past and of the present is within the reach of all who have the desire to read the open pages of Nature's book. In the rocks we find the soul of history: the whole world throbs with life, and the joy of it all is ours to share:

"I said it in the meadow path,
I said it on the mountain stairs—
The best things any mortal hath
Are those which every mortal shares."

We have caught here through the mists a glimpse of a scene on earth's stage separated from the present by a small fraction of time in relation to the whole span of geological history. The Thulean forests which we have visited included trees, shrubs, and other plants of surprisingly modern aspect, though it is not to be supposed that they were absolutely identical specifically with their living descendants; from the material available it is impossible to define or assess the difference. What we have seen throws little light on the evolution of the plant-world; it is equally true that the main conclusion forced upon us by our retrospect cannot fail to convince us that it is impossible to understand the present distribution of plants over the earth's surface unless we extend our survey into the past. Darwin spoke of geographical distribution as a noble science, "almost the keystone of the laws of creation". The living world cannot be fully appreciated as an expression of creative energy unless we free ourselves from the cramping influence of the environment in which we live.

As a botanist whose first love was geology, may I make a plea for wider recognition of physical geography and geology as branches of knowledge possessing an inestimable value as a means of bringing young people into close companionship with Nature and as a source of refreshment, a stimulus, and an inspiration. Most of us would probably agree with the spirit of a remark made a good many years ago by the late A. C. Benson: "I find it hard to resist the conviction that, from the educational point of view, stimulus is more important than exactness". Arguments in favour of introducing geology into schools were put forward in a report on scientific education presented at the Dundee meeting seventy-two years ago, and in 1936 and 1937 the Association published two reports on the same subject. Let me add another argument of no little value: Hugh Miller wrote in a letter to a friend: "Geology is, I find, a science in which the best authorities are sometimes content to unlearn a good deal". That is worth much: geology helps us to cultivate the not too common virtue of admitting that it is possible to make a mistake.

In conclusion, I cannot do better than quote with wholehearted agreement words spoken by Sir William Bragg in his presidential address to this Association eleven years ago: "Some speak of modern science as tending to destroy reverence and faith. I do not know how that can be said of the student who stands daily in the presence of what seems to him to be infinite". These words apply with equal force to searchers after truth whose main interest is in the living world, no less than to those whose objective is the elucidation of the structure of matter that is called by contrast dead and yet vibrates with life. The earth was once lifeless: when and how living protoplasm had its birth we do not know, nor do we know whereupon were the foundations of the earth laid. We can only echo in our hearts the voice out of the whirlwind:

"Whereupon were the foundations thereof fastened?
Or who laid the corner stone thereof;
When the morning stars sang together,
And all the sons of God shouted for joy?"

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

Instruments in Science and Industry

THE presidential address by Mr. R. S. Whipple to Section A (Mathematical and Physical Sciences) is largely devoted to showing how much the progress of the sciences depends upon the development of the instruments employed. A few well-known instruments are selected as examples—the microscope, telescope, spectroscope, etc. Their development has a long history and each can be adapted to yield accurate measurements by the addition of suitable devices.

One of the earliest scientific workers, the Dutch naturalist Leeuwenhoek, during the period 1674–1723, discovered by means of a single-lens microscope the protozoa and bacteria, and made many other discoveries of supreme importance. Although many variations in the design and mechanical construction of the microscope were made during the eighteenth century and the early years of the nineteenth, yet there is no invention of fundamental importance to record until the construction of the achromatic objective. This was first successfully completed by the French optician Chevalier about 1825. Abbe carried the corrections to a far higher degree of perfection, notably by using glasses of new types which at his suggestion had been worked out by Schott, to produce, about 1886, the so-called apochromatic objective. It is difficult to see how the resolving power of the microscope is to be increased further using light from the visible region of the spectrum; the alternative is the employment of rays of shorter wave-length.

J. E. Barnard has developed a successful technique in connexion with ultra-violet microscopy and has shown that it is possible to study and photograph living bacteria, which are normally transparent to light from the visible regions of the spectrum.

The use of short-wave radiation has proved so successful in the case of the ultra-violet microscope that great interest is being shown in the development of instruments using still shorter radiations. It is possible, in a suitably designed piece of apparatus, to use a beam of cathode rays to obtain photographs of bacteria and bacilli at magnifications as high as 20,000 diameters.

Although a Dutchman, Lippershey, discovered the telescope, yet it was Galileo who first produced an instrument worthy of the name. He ground and polished his own lenses and in 1610 discovered the satellites of Jupiter. Newton pointed out that the focal length of the refracting telescope could not be reduced owing to the refrangibility of light of different colours and the impossibility of focusing for all the colours simultaneously. In 1663, James Gregory suggested the reflecting telescope, and five years later Newton constructed the first satisfactory instrument.

Herschel made many specula of high quality, culminating in one of 4 ft. diameter for his Slough telescope. Owing to the increasing demand for telescopes of higher magnification, and of increased light-gathering power, the size of the mirrors used in modern instruments is steadily increasing. An instrument is now being constructed for the Mount Palomar Observatory in which the mirror is 200 inches in diameter.

The highest accuracy obtainable is required in the divided circles of astronomical and surveying instruments. In the latest form of theodolite the circles are made of glass, the divisions being etched upon them. The advantages of the divided glass circle are so marked that the new reversible transit instrument for the Royal Observatory, Greenwich, is provided with such circles, 28 inches in diameter.

The spectroscope is proving of great service in industry both as a tool for rapidly analysing samples of materials and for detecting impurities. The value of the instrument in advanced physical work cannot be easily exaggerated.

After discussing briefly the instruments used in the measurement of time, Mr. Whipple considers the importance of modern electrical instruments and the large part that will probably be played in their future development by the thermionic valve. In concluding, he stated that he was much impressed with the steadily growing demands for higher accuracy in all measurements. As new problems arise both in science and industry the requirements become more stringent. The instrument maker constantly receives incentives to progress from the scientific worker, to whom he owes not only suggestions but also many of his new materials. If knowledge is to progress, it is essential that theory and practice advance together. Nowhere is this more true than in the development of scientific instruments.

Film Reactions as a New Approach to Biology

TOWARDS the end of the last century, the biologist considered that the biological entity was the whole living unit. In recent years the interest developed in specialized processes such as enzymatic reactions has tended to obscure approaches to the mechanism of co-ordination and integration of activities of a cell. Since an analysis of the colloidal properties of living matter reveals that a large fraction of the material and energy lies in a new phase, the interphase, it seems pertinent to inquire how far physical and chemical reactions may be modified when the reactants are confined to an interphase. This is the subject-matter of Prof. E. K. Rideal's presidential address to Section B (Chemistry). The general considerations in respect to composition and structure of the interfacial phases have long been known and have been exhaustively examined during the last twenty years. More recently, attention has been directed to the physical properties of monolayers of the macromolecules, such as the proteins and methylated celluloses and starches. These are of interest in that two-dimensional gels, prototypes of membranes, can be formed. The fact that the molecules in monolayers are orientated in respect both to the substrate and to their neighbours, and that this orientation can be affected by expansion or contraction of the monolayer, is shown to have an important bearing not only on the rates but also on the height of the potential barriers involved in the reactions. Many examples are noted in surface chemical reactions, including both enzyme activities and photochemical processes.

Since the molecules at the interfaces are orientated, in two component systems molecules of different species can be adlineated with respect to one another. Under these conditions the interaction energies comprising both the polar as well as the non-polar portions attain maximum values, and stable complexes frequently result. The formation of these complexes is brought about by the penetration of a monolayer of one species by the molecules of the penetrant. These penetrative reactions appear to be involved in various biological processes such as lysis, agglutination, or sensitization, and to play a part in the action of various drugs. Complexes formed in this way may be broken by other reactants and can likewise serve as carriers for an otherwise non-transportable reactant.

Penetrative reactions involve the penetration of a monolayer by a reactant containing but one reactive polar group. If the reactant contains two or more of such reactive groups, on injection beneath a monolayer the reactant will be adsorbed by the monolayer and form a series of interlinks. An extensive interlinking results in the formation of a non-dispersable tanned skin possessing distinct properties. Finally it is pointed out that action as opposed to injury currents can be imparted to such a system by periodic alteration of the orientation of the molecules of an interphase.

Metamorphism and Igneous Action

THE consideration of the relation between metamorphism and igneous action, which forms the subject of Prof. H. H. Read's presidential address to Section C (Geology), falls into two parts. First, a brief historical summary of the peculiarly national contributions serves to display the wide divergences in opinion on this question. The views of the Rosenbusch school of pure thermal metamorphism are contrasted with the imbibition notions of the French, and the work of Becke of Vienna, the Swiss, Sederholm of Finland and the Americans is reviewed. The classic investigations of George Barrow on zones of progressive regional metamorphism in the highlands north of Dundee and their causal relation to granitic injections are sympathetically summarized.

In the second part of the address, a discussion is presented of the origin of regional metamorphism, that is, of the transformations which have affected large portions of the earth's crust. Prof. Read objects to the customary view that regional metamorphism and dynamic metamorphism are equivalent terms, and suggests that, apart from the dominantly cataclastic effects produced in rocks by patent dislocations, metamorphism is not directly controlled by orogenic deformation. The preservation of original sedimentation textures, the coincidence of schistosity and bedding, the horizontality of schistosity over wide areas and mimetic crystallization generally are observed features which are incompatible with dynamic action.

To account for these features, the operation of a static or load metamorphism in which the transformation is considered to be due to the vertical pressure of superincumbent beds has been invoked by some. Objections to the validity of load metamorphism are, however, many. The existence of completely non-metamorphic rocks which have nevertheless been covered by an immense thickness of strata, high-grade metamorphic rocks resting on lower-grade rocks, and the narrowness of metamorphic zones are examples of these objections. Load, by itself, is not enough.

Prof. Read considers that metamorphism is not a function of depth. He suspects that the notion of the great depths of high-grade regional

metamorphism flourishes because of the supposed necessity of carrying rocks down to be metamorphosed, and suggests that as an alternative we should consider bringing the metamorphosing agents up. This can take place in connexion with granitization and the formation of migmatites. Whatever be the origin of granitic magma, it has been demonstrated in dozens of localities that solid rocks have been converted into rocks of granitic character. In the production of such migmatites, replacement must be the essential process, and it is reasonable to believe that during this replacement there occurs an emigration of material into the country-rocks adjacent to the theatre of granitization. Around the migmatite core, therefore, zones of various characters depending upon the localization of different precipitation-fronts are formed.

One of the most firmly established facts of metamorphic geology is the close association of highest-grade metamorphic rocks, such as those of the sillimanite and cordierite zones, with migmatites. This association has been variously interpreted, but Prof. Read agrees with Barrow and others in seeing in it a direct causal connexion. These high-grade rocks, however, are but the final stages in the progressive series of zones which supply the common types of regionally metamorphosed rocks. It seems reasonable to suggest, therefore, that regional metamorphism as a whole is genetically related to igneous activity of some kind. Out from the central theatre of granitization there pass waves of metasomatizing solutions, changing in composition and in temperature as they become more distant from the core and promoting thereby the formation of zones of metamorphism about it. Relief is obtained in the outer and cooler zones by shearing, in the inner and hotter zones by internal reconstructions. Such a metasomatic metamorphism accounts for the superposition of high-grade on low-grade rocks, for the preservation of original textures, for the coincidence of schistosity and bedding, for the changes in chemical composition of the progressive zones and so forth.

Prof. Read's conclusion, which is offered for discussion, is that all rock transformations may be classed into two groups, those of dislocation-metamorphism associated with dislocations of the crust, and those of regional and thermal metamorphism, associated with igneous activity.

Perspectives in Evolution

THERE are some general problems regarding life and evolution which are best comprehended by analysis of long-range views of existence upon the earth. Some of these problems were restated in the light of recent knowledge by Prof. James Ritchie in his address to Section D (Zoology).

Investigation of the properties of living things has led to modification of the extreme mechanistic and vitalistic views of life and has gone far in reducing its mystery to terms of physics and chemistry. Theories of the cell as an electromagnetic unit and of life as the dynamic equilibrium between such units, or of life and the cell as originating in an etherial vortex are less convincing than the researches which show that certain activities of cells conform almost perfectly to the laws of osmotic systems, to Donnan's membrane equilibrium, and to catalytic action brought about by enzymes. None of these interpretations, however, reaches the ultimate secret of life, the quality of which is apparent in a perspective of evolutionary processes.

Living organisms have assorted and aggregated vast deposits of calcareous and siliceous ooze from the dilute solutions of the ocean, and have gathered great formations of coal and peat from the tenuous stores of carbon dioxide in the atmosphere. This is something quite different from the physical fate of gases or solutions, which normally progress towards maximum dispersal of their particles. Moreover, the evolution of life itself, from simple to more complex, is an increase in orderly arrangement apparently opposed to the thermodynamical law of increasing randomness. From this point of view the characteristic of livingness is that it appears temporarily to hold up or withstand the physical course of degradation of matter, if it does not actually reverse it, through its power of trading with the environment so that it can build up stores of high potential energy from materials of lower potential.

Another notable development which must influence evolutionary thought is the lengthening perspective of life upon the earth. Newer and consistent information about the ages of geological formations based upon the break-up of radioactive minerals in rocks emphasizes generally and in detail the stability of living organisms and the slowness with which evolution has taken place. It emphasizes still more the significance of man as an agent of change in the living world, for his active part in modifying life upon the earth is practically confined to our era and mainly to the last three hundred years. In that insignificant period he has wrought faunal changes in civilized lands which can be compared only with the great secular changes of world evolution.

Realization of the 1,200 million years through which life has been evolving leads to an attempt to view mankind and the future of man in evolutionary perspective. His past is insignificant in time; his long future is unknowable so far as

science is concerned. But bearing in mind the impetus of evolution, it is reasonable to suppose that in the immediate future (geologically speaking) his progress will be continued towards perfection of social life and the widening of the social idea to include peoples and nations as well as individuals. What of his long future, in the vista of a thousand million years still to come? The history of life upon the earth makes it seem presumptuous to suppose that with the coming of man evolution should cease or should be tied for all time to come to trifling changes in brain-power or better social organization for mankind. It suggests that man, so far the greatest of the manifestations of life upon the earth, may be no more than a stage in life's progress and a milestone upon the path of evolution towards a greater future.

Method in Geography

MR. A. STEVENS points out in his presidential address to Section E (Geography) that during the last thirty-five years, it has been customary in geographical writing to pay some sort of service to the concept of natural geographical regions as distinguished from the 'political' divisions of the earth formerly in use. Immaturity of thought is indicated by the terms in use: natural (physical) region, economic region, human-use region. It arises from the inclination to see the matter of geography as a duality and its method as synthesis or integration. Fertile scientific work, the definite emancipation from scholasticism of modern intellectual processes, has depended on confining each branch of study to a single material category, and this problem has not been solved in the case of geography. Neither synthesis nor integration is possible where the factors and conditioning circumstances are too complex and difficult fully to be enumerated, let alone evaluated, as they are in the field with which geography attempts to deal. As to method, the subject must limit itself to the analytic: further examination of the natural region concept should contribute to the definition of its matter.

The natural region must be defined with regard to neither the physical nor the human or economic severally, but to both in symbiosis, in natural synthesis. The natural geographical region is the organized or living region. Organization depends on occupation by man and the development of a system of communications the functions of which are analogous to those of both the circulatory and the nervous systems of living organisms. The functioning of such regions with special reference to space is the study proper to geography, as that proper to history is such functioning in time (or sequence). Space and time may not fundamentally be independent variables, but they may be made the basis of partial differentiation. There is the story of the evolution of communications from the porter to the aeroplane, from the smoke signal to the radio. There is also the question as to how precisely communications have managed space.

Organized regions have their ontogeneses. At a given time a region may be *saturated* and its development mature, as, some time in the past century and a half, occurred in Western Europe; or it may be undersaturated and juvenile as is the New World to-day. Until a certain degree of maturity has been attained, the region cannot be defined in detail. The conditions for saturation depend on the state of economic development.

The major natural geographical regions of Europe are the European countries. A geography of Europe not based on the characteristic European phenomenon of the nation-State is absurd. Spatially these regions are quite out of proportion to modern possibilities of communication, the means of organization and cohesion.

Rates and Taxes

PROF. H. O. MEREDITH'S address to Section F (Economics) entitled "Rates and Taxes" is a plea for more serious consideration of the distribution of the tax burden through society in view of probable increase in the ratio of public to private expenditure.

It is alleged that while the policy of *laissez-faire*, as understood by the Victorians, has been abandoned, we have failed to develop a financial practice comparable in logical coherence with that of Gladstone. In consequence, our finance is more and more passive and less and less capable of advance in good time on constructive lines. "Instead of grasping our nettles, we wait until we are stung". Defect of intelligible principles is illustrated by the case of income tax abatements in respect of children, and the policy of derating; and the question is ultimately posed of whether any of our existing sources of revenue are really satisfactory with the exception of income tax and sur-tax and the duties levied on property passing at death. The case against indirect taxes upon commodities and the local rates is argued at considerable length, attention being directed particularly to the sinister influences which have in the past promoted indirect as opposed to direct taxation. The arguments in favour of these sources of revenue are also examined and the conclusion is reached that little, if any, force is attached to any of them here and now, whatever may be or have been the case in other countries or at other times. Special attention is directed to the disputable character of the widely held opinion that virtuous

conduct may found a valid claim to exemption from taxation and vicious conduct establish a case for pecuniary penalty.

Finally it is claimed that these methods of raising revenue must inevitably, under modern conditions, distribute the burden of taxation partly in an indiscriminate and partly in a clearly noxious way. In its concluding section the address propounds the theses that taxation ought to be felt and that every citizen in a community ought to pay and know that he is paying at least some minimum contribution to the expenses of the State.

The Future of Flying

THE presidential address to Section G (Engineering) provides each year an opportunity for a survey of some aspect of engineering science which happens to be of especial importance at the time it is given. The subject chosen by Mr. Wimperis is "The Future of Flying". Of its importance at the present time there can be no doubt. Aviation is surveyed by the public with a tempered pride; pride it is true in man's achievement, but apprehension as to the use which is being made of it.

The aspiration towards winged flight was expressed with wisdom when, more than two thousand years ago, the Psalmist avowed his longing for "wings like a dove". Mankind possesses the power of flight—a marvellous scientific and technical triumph; but brilliant as was the work of the pioneers, the crown of achievement cannot be regarded as won until mankind sees that the wings gained are indeed the wings of a dove, not those of a bird of prey. Every new invention has its warlike use as well as its peaceful purpose, and each has challenged men's wits to ensure that good, rather than harm, shall result from the new discovery. To bend the newest invention of all, the conquest of the air, to the service of mankind is now his great task. In it, success is essential lest we presently find that it is the air that has conquered mankind rather than mankind the air.

That the cleaning up of the aerodynamic structure would carry aircraft performance much further than had hitherto been realized was first pointed out, little more than ten years ago, by Prof. B. M. Jones of Cambridge. This required that all excrescences should be removed, and of these some of the worst were then the interplane struts and wires. When that had been achieved it was realized that much of the equipment hitherto carried externally, especially in military types, must be put inside, and with that attained, after a severe struggle, there arrived the modern streamlined aeroplane with its undercarriage, and even its tail wheel retractable into the body of the structure.

As a consequence the speeds of military aircraft are now in excess of 400 m.p.h. and will rise to 500 and possibly even 600 m.p.h. But civil aircraft rarely go faster than 250 m.p.h., and it is doubtful whether it is economically advantageous to have even so high a speed as that. This at once makes a great difference between the two types. Moreover, the comfort and space needed for civil transport tend to produce a design of body which does not in the least resemble military requirements, and in so far as the civil types, in their really large sizes, come more and more to take the flying boat form, so are they the less like military types.

In Mr. Wimperis's view there will be no reason, once the international situation has cleared, why there should not be an agreed limitation, in respect of numbers or tonnage, of bombing aircraft—leaving the interceptor fighters entirely aside. It would be but cautious to agree on a limit to the speed of civil types; but as this would merely confirm what economic requirements would themselves require, it need be no hardship to anyone; excessively high speeds for civil types do not pay, are much more dangerous to passengers, are much more noisy to everyone, and need extravagant air ports.

Scope and Limitations of Physical Anthropology

ANTHROPOLOGY spreads its domain over unusually wide fields of scientific inquiry, and it is becoming increasingly impossible for the representatives of the different branches of the subject to maintain intelligent contact with each other and to judge of the validity of the evidence which is presented in branches other than their own. In his presidential address to Section H (Anthropology), Prof. W. E. Le Gros Clark discusses the present position of physical anthropology and its future prospects.

Intensive studies in comparative anatomy have established broadly the relation of man to the lower primates; but evidence of this nature is necessarily limited since it is often impossible to assess the relative taxonomic value of different anatomical or physiological characters. The extension of our knowledge of the zoological status of man must now await the accumulation of palæontological data. The existing palæontological evidence of the origin of man is briefly reviewed, and stress is laid on the difficulties of interpretation when only fragmentary fossil remains are available for study. Physical anthropologists in the past

have been somewhat too confident in the general inferences which they have drawn from such scanty evidence, and erroneous conclusions have frequently been based on an inadequate appreciation of the great range of variability in fossil and recent man. It is much more difficult than is generally supposed to draw even simple conclusions, such as those regarding sex and race, from the study of the skeleton alone.

The validity of taxonomic characters in the study of racial differentiation demands a careful study, and it is necessary that anthropologists should make more detailed inquiries into the genetic basis of the characters which they commonly use. There is evidence that even the shape of the skull is susceptible to nutritional and other environmental influences. Craniometrical evidence is further complicated by the possibility of parallel mutations, a phenomenon which is well known to occur with other physical traits. Consequently, craniometrical resemblances do not necessarily indicate correspondingly close genetic affinities. It is necessary to endorse the criticism of Prof. R. A. Fisher that, for the study of racial problems, physical anthropologists might more profitably direct their attention to living populations rather than rely on skeletal material, which too often is unsatisfactory and inadequate.

Apart from palæontology, it may be doubted whether physical anthropology as a historical science is likely to advance our knowledge of racial origins and racial differentiation very much beyond its present state with the techniques now commonly used. On the other hand, there are many profitable lines of inquiry which are waiting to be explored in other fields of physical anthropology. Many biological sciences have passed or are passing through what may be termed the 'museum stage' of their development, a stage involving the collection of material in the laboratory, its detailed examination and classification, and the interpretation of the facts which it presents in the form of general hypotheses. To complete its natural metamorphosis, physical anthropology should also now be emerging from the museum stage and developing along experimental lines or along the lines of active observation in the field.

The study of the bodily changes which man has undergone in the past gives a clue to the nature and extent of the changes which may be anticipated in the future. But what is far more important for the same purpose is the study of man as he is to-day. Sociological problems are becoming more and more forced on our attention which demand for their solution a conscious control of processes which have hitherto been left to chance. The improvement of health and physique and their relation to nutritional and climatic factors, the relative importance of hereditary factors in determining the distribution of physical characters, the results of the hybridization of different racial types, the effects on physical type of the redistribution of the populations of the world, the relation of changes in the reproductive rate to human variability and the composition of regional populations, all these are practical problems which can be approached systematically and scientifically only if we have adequate data regarding the physical nature of man in the conditions under which he now lives.

There is little doubt that the physical anthropologist of the future must be essentially a field-worker if he is going to develop his subject along progressive lines. Since, also, physical anthropology is one of the biological sciences, he must be a man of sound general biological training if he is to acquire a real insight into the problems which are set for him.

The science of physical anthropology has already contributed much to the study of the past history of the human species. By the study of modern populations it has a still more important function to fulfil, namely, the accumulation of data on the basis of which it will be possible in some measure to control the destiny of mankind.

The Assessment of Physical Fitness

IN the House of Commons on Thursday, July 20, 1939, the Prime Minister said, "I am presenting a very serious argument. What is going to be the result of this increased expectation of life, coupled with the diminution in the birth-rate, which is going on at the same time? In 1931 the number of persons of 65 years and over was, in proportion to the number of people between 15 and 65—the earning age—as 11 to 100. In 1955 that will have risen to 16 to 100 and in 1975 to 20 to 100. It may be said that that is a long way off and we shall not know anything about it, but surely we ought, if we have a proper sense of responsibility, to consider what is going to be the effect on the next generation of anything that we may be doing to-day. The implication of the figures have given is this: That as time goes on there will be an increasing proportion of the population who will be eligible for pensions and to whom pensions will have to be paid, and there will be a decreasing proportion of the population who will be earning wages and therefore able to make contributions to pay them."

In 1930, after the Contributory Pensions Act was passed, the cost to the Exchequer was £46,000,000. The estimates for the current year showed a charge of £69,000,000, and in the course

of the next forty years the estimated annual cost will rise to £115,000,000 at the present rates of payment.

To blacken the picture still further, the only grade of the population that has a high birth-rate is the lowest in the social, economic and biological scale. It is therefore of importance to have some means of carrying out an audit of the physical fitness of the population so as to ensure a rational means of raising the general level of fitness.

Methods of assessing fitness are classified as somatometric, physiological and psychological. In his presidential address to Section I (Physiology), Prof. D. Burns reviewed the various indexes of fitness in general use and dealt with their validity. He restricted his discussion to the testing of subjects apparently healthy from the clinical point of view.

Somatometric assessment *per se* is of very little use as fitness is functional, depending not so much on the structure of the body as on the way it works, and on the speed and accuracy of the various correlations involved in action; and on the determination of the subject to do his best. Tests of cardio-vascular efficiency combined with some form of 'stunt' test may be considered reliable indexes of fitness.

Measurement in Psychology

In his presidential address to Section J (Psychology), Mr. R. J. Bartlett deals with measurement in psychology. In using the measurements of physics to evaluate the objective products of mental activity, psychology finds as an essential feature of its data a scatter which makes statistical treatment of that data necessary. No progress could have been made without accepting what Dr. Darwin, last year, in his presidential address to Section A, called "the fuzziness inherent in absolutely all facts of the world".

Intensity is a characteristic of sensory experience which has occasioned controversy that still leaves divided the committee of Sections A and J set up in 1932 "to consider and report upon the possibility of Quantitative Estimates of Sensory Events". Apparently much of the difficulty arises from confusion of two sources of 'error'. Sensitivity, in its true sense is a 'scatter error', would seem to be slightly superior to the demands of the Weber ratio, $\Delta I/I$, and is not subject to decrease with extreme stimuli. The rapid increase in the Weber ratio, as ordinarily determined, is due to a 'constant error', dependent on a memory factor and causing regression towards accustomed values.

After a review of experimental investigations of reaction times, bodily and mental work, and the physiological concomitants of emotional-conational experience, in which the methods and measurements used are those of physics and physiology, measurements peculiar to psychology are considered. In 1924 a Board of Education report on "Psychological Tests of Educable Capacity" concluded that intelligence tests were of value. The original 54 'manifold and heterogeneous' tests of Binet, compiled in 1905 for the diagnosis of mental deficiency, have become, in the 1937 revision of Terman and Merrill, two sets of 129 tests each, covering mental ages from 2 years to 22 years 10 months and measuring intelligence quotients up to 170 for children and 152 for adults.

Spearman's great contribution to work on intelligence was the introduction of methods of correlation to establish the value of tests. From his work he educed the two factor theory and tetrad criterion—a mathematical method of general application.

Work of the Industrial Health Research Board, the National Institute of Industrial Psychology and other research has given tests for abilities and skills of value in industry and for particular disabilities that unfit for certain occupations. These, as tests for vocational guidance and selection, are being used with increasing frequency.

There follows the measurement of personal attitudes and interests, as in the case of Thurstone and Chave's 'attitude to the Church scale', which enables a person's attitude to be assessed in a scale ranging from enthusiastic support to bitter antagonism. Similar methods have given social maturity scales and enabled a start to be made with the measurement of temperament and character characteristics.

Steady progress made, from measurement of sensory discrimination, through measurement of intelligence and measurement of abilities and skills, to measurement of attitudes and interests and measurement of temperament and character traits, justifies psychologists in expecting yet greater achievements and in not being unduly disturbed by the criticisms of those who continue to hold, with Malebranche, Leibniz and Kant, that psychological data contain nothing 'that can properly be called measurement'.

Interpretation of Plant Structure

Prof. D. Thoday, in his presidential address to Section K (Botany), traces the change of outlook in plant anatomy from the adaptational and the phyletic to the causal and developmental.

Using xerophytes as example, he shows how difficult it is to assess the functional effects of

structural features with exactitude. Xerophytes co-existing in the same habitat vary greatly in the efficiency of their structural provision for controlling the loss of water and are not as a class characterized by low rates of transpiration. Contrary to teleological expectation, stomatal frequency is higher in plants growing in exposed places; it is affected by the degree of expansion of leaves, under different conditions, after the stomata have been initiated. Correlations between vascular tissue in leaf and stem, too, require a causal rather than a functional interpretation and point to the influence of one part upon another during development. The discovery of hormones in plants, especially of auxins, which among other effects stimulate cambial activity, justify such an interpretation of structural correlations.

Phyletic studies have had only limited success in the tracing of phylogenies, but have revealed numerous instances of parallel evolution. These direct attention to the nature of major changes, which do not present the haphazard appearance of those which cytology has revealed. It is suggested that, from the lowest chemical plane upwards, the important factors were inherent probability of particular changes, and *selection of harmonious changes*, in dynamic systems. The study of development from a causal point of view may therefore throw light on the nature of the major changes in evolution. The material for comparative morphology consists, not of three-dimensional, but of four-dimensional patterns.

Prof. Thoday then approaches seedling structure from a causal point of view. He suggests that the shoot and root apices, as organizing centres, determine between them the vascular structure of the hypocotyl, the variations observed reflecting different degrees of dominance and extent of influence of one or the other, in different species and at different phases of development. The number of strands of procambium reflects the early influence of the cotyledons, sometimes also of the plumule. Exarch protoxylem, with flanking strands of phloem, reflect the influence of the root, and represent the smallest symmetrical arc-segment of the repetitive root-pattern. Subsequent centrifugal development of xylem shows the increasing influence of the shoot. Adventitious roots, especially polyarch roots of Monocotyledons, and the successful culture of excised root-tips, show that the root apex is self-determining as regards its structural pattern. In dicotyledons, however, no secondary growth is initiated apart from the shoot.

Williams's experiments with rhizophores of Selaginella show that hormones may throw light on morphological problems. While, however, hormones may be agents in the correlation of development, they do not account for the processes that are correlated. By reference to the development of the adhesive disk and haustorium of *Viscum album*, Prof. Thoday emphasizes that differentiation consists in the active response of living cells to various influences, which in this example are largely external, but in ordinary plant organs are mostly internal. Inheritance of structure is thus inheritance of behaviour patterns, the subtlety of which transcends our present conceptions of chemical or structural change in chromosomes.

Education for Industry

IN his presidential address to Section L (Education) Dr. A. P. M. Fleming directs attention to the vital part which the manufacturing industries play in the economic life of the nation, and points out that the well-being of these industries depends on the personnel engaged in them, so that the education and training of this personnel is a matter of great national concern.

The function of industry is to transform raw materials into useful commodities, and in both the social and economic sense it is the manufacturer's responsibility to the State to effect this conversion with the minimum of waste of time, effort and materials.

Industry is never static and particularly is influenced by the continual accession of new scientific knowledge. Hence there must be similar mobility as regards the outlook on industrial education.

The education of industrial personnel is considered in relation to two main groups of employees —manual and non-manual workers—and embraces entrants from all educational levels from the elementary school to the university.

In progressive manufacturing concerns it is becoming increasingly the practice—and this applies to all grades of personnel—to seek entrants who have received an appropriate education in fundamentals and to provide the required specialized training during the early years of employment. This practice applies equally to skilled artisans, foremen, supervisors, draughtsmen, designers, salesmen, research workers and those who eventually attain the highest executive positions.

The industrial education of the future must envisage the continual addition of new scientific knowledge, which is the basis of all industrial progress and particularly the development of entirely new industries.

The increasing mechanization of industrial processes and the tendency to reduce hours of labour should enable technical instruction to be given in

the daytime and thus eliminate part-time evening technical study, leaving leisure for cultural pursuits and opportunities for increasing physical fitness.

At present the facilities for imparting practical instruction within industry are by no means fully utilized, and there is need in this respect for greater co-operation between industrial concerns. The practical training of industrial personnel is a national service to be conducted irrespective of any narrow commercial considerations.

The raising of the school-leaving age will have the effect of rendering practical training more intensive and will bring into prominence the question of the length of time really required for the effective practical training of every type of industrial personnel. Greater co-operation is needed between industry and education in the matter of providing adequate teaching staffs, notably in connexion with the technical institutions and universities. Post-advanced courses will, to an increasing extent, bridge the gap between the adoption by industry of newly developed scientific processes and the availability of knowledge of such processes in text-books used for the more conventional teaching courses. The extension of scholarships and fellowships to industrial students is desirable, especially those of such character as lead from general education to actual employment in a job after university education has been completed.

Though the importance of education and training of an industrial character is stressed, it is appreciated that all education must be liberal, and even to meet the urgent needs of industry no technical specialization should be permitted which excludes the possibility of time being devoted to broadening the mind in both the mental and the social sense.

Science and Agriculture

SIR THOMAS MIDDLETON, who takes as the subject of his address to Section M (Agriculture) "The Farmer's Position and the Scientific Worker's Programme", refers to the well-known motto of the Royal Agricultural Society of England, "Practice with Science", and contrasts the fortunes of the farmer and the scientific worker a century after the motto was adopted. The progress made by science would cause astonishment to those who chose the motto; the condition of agriculture would disappoint their hopes. Agriculture's achievements were then judged by the capacity of the country to maintain its people, and the soils of Great Britain supported about seventeen millions. To-day, although no doubt the quality of our farm produce has improved, our soils support some fourteen millions only. Moreover, as is generally known, the difficulties of farmers are so great that even in a year when Parliament has been greatly pressed for time and the Exchequer for money, much time has been given to the discussion of agricultural matters and some money has been spared for assisting the farmer. Aid has been called for since, in the post-War years, rising costs, low wholesale prices and uncertain markets have depleted the farmer's resources to an extent that makes the requisite treatment of the soil impracticable.

References are made to the incomes of arable farmers in north-east Scotland and eastern England which show that, when a moderate interest is paid on capital, the farmer's earnings in recent years have approximated to the wages earned by cowmen and shepherds. In the United States in the early thirties the farmer's earnings did not equal those of his hired men, and similar conditions were faced by farmers in other countries, such as Canada, Holland and Denmark. Poverty among peasants and agricultural labourers has been widespread. A Committee of the International Labour Office has recently shown that in twenty-three countries studied by it an improvement in the condition of land workers was urgently called for.

The reasons for the meagre reward of those engaged in the production of man's primary need are discussed; some are due to the producer's fellow-countrymen, others to the farmer himself. The nature of the farmer's calling is such that he finds it impossible to equate supply to demand. Thus, as a competitor in the food market, he occupies a weak place and is compelled to accept as remuneration for his work what is left over after others in the food industries have secured a margin which satisfies them.

In the second part of his address Sir Thomas Middleton alludes to the increase in the financial resources of scientific workers in agriculture and claims that this increase is justified because of the value of the work to the nation. The fact that markets may be over-supplied, though unfortunate for the farmer, benefits the public.

In the United States, where surplus commodities created great difficulties for the administration, there was no limitation of scientific work because of surfeited markets; on the contrary, all available scientific assistance was enlisted in an endeavour to recover from the recent depression. A similar lead has been given by our own forefathers. When, in 1839, Britain had passed through difficulties as great as those recently encountered in the United States, the agricultural leaders of the day took "Practice with Science" for their motto. Since science is incomparably better qualified to help

and farmers are far more ready to seek its aid than before, we have now, in facing an uncertain future, reason to do so with the courage, as with the motto, of our ancestors of 1839.

After a brief reference to investigations in progress at some of our agricultural institutions, the subject of food supply in war is discussed. The coming of the aeroplane calls for changes in English farming which would enable food production to be increased rapidly should war break out. Attention is directed to the ease with which production was increased in Scotland in 1917 and 1918 as compared with the very great effort required in England, and it is argued that many English farmers, who now keep their land permanently under grass, should adopt the Scottish system of the temporary ley. The principal change desirable in English methods is thus the change for which Sir George Stapledon argued so strongly in his address to Section M at last year's meeting of the Association. It is a change which, superficially, would appear to be easy. In fact it presents many difficulties which call for careful study, and study from different points of view. Scientific workers in framing their programmes should ask themselves how best they may contribute to a solution of this problem and thereby enable agriculturists to increase food production rapidly should the need arise.

Although all our usual foods would demand attention, the chief effort in war would be to secure an increase of energy-supplying food. At the present time about 70 per cent of our energy supply is imported. Experience in 1914–18 suggests that, farmed as Britain now is, it would be difficult in war to provide more than 35 per cent of our requirements. This was the percentage which the United Kingdom raised at home in the years 1909–13. In 1918, favoured by the season, the figure was raised to 42 per cent, but since that year the area under grass in Great Britain has increased by nearly four million acres, and land under grass is unlikely to provide even one-fifth of the human food produced by cultivated land under cereals and potatoes.

The duration of wars cannot be predicted, nor can we forecast the effect on sea-borne supplies; we should not rely on storage and shipping to supply as much as 65 per cent of the food we should need in a prolonged war. The food production campaign of the future may be required to aim at a six months' supply. Britain now has about 17 million acres under permanent grass; if on four to five million acres of the most suitable land temporary were to replace permanent grass, so as to increase the area of arable land to about 16½ million acres (the area of fifty years ago) and the fertility of this arable land was maintained at a satisfactory level, the production of 50 per cent of our food in war should not prove to be beyond the combined efforts of our farmers and scientific workers.

Local Scientific Societies and the Community

PROF. H. L. HAWKINS, in his presidential address to the Conference of Delegates of Corresponding Societies, emphasizes the opportunities for team-work that these societies afford. While the society should not become too parochial in its interests, nor lapse into a picnic-club, its local and social aspects are both essential to its success. Interest, not erudition, should be the criterion of membership.

Much useful work in natural history depends on observation, so that topics accessible to the majority of members will give most satisfaction. A society in a coastal town can study marine conditions that would be outside the scope of one located in a midland city.

Every local society should control the mania for collecting. Great advances in this respect can be recorded; rarities are rarely exterminated to-day in the name of science. But some people still need reminding that it is criminal to celebrate a meeting with a long-sought friend by dragging home his corpse.

Collecting specimens, living or inanimate, dissociates them from their environment. Specimens become curiosities of little value without particulars of the circumstances of their occurrence. For inanimate objects the collector can, if trained to observe, record all the features of their environment that are likely to be significant; but where living things are concerned, an individual cannot deal with all the factors that may have influenced their occurrence. The arrival of a migratory bird may be controlled by the appearance of a particular insect, and this may depend on the growth of some plant the development of which may have been affected by the weather of the previous season. Here is the opportunity for team-work.

Local scientific societies have a splendid opportunity for compiling statistics of transient phenomena. Every recurrent seasonal event invites, and should receive, accurate observation and a permanent record. Each society should encourage its members to keep statistics on all such topics. Large-scale maps for plotting localities, and a card-index for the records, and perhaps a retired businessman to keep order, would soon provide a mine of information packed with unsuspected wealth.

This suggestion may be thought to be concerned more with the relation of a scientific society to science than with its reaction on the community.

Such a view is not only narrow, but also out of date. Prophecy is based on knowledge of past history. The statistics suggested above are the raw material of prophecy. If such truly natural history of a few decades were available, many of the problems that confront every farmer, and so every consumer, would meet at least partial solution.

In these critical times, statistics of the natural resources of the country are being eagerly compiled. There could be no better compilers than local residents trained to observe facts and to tabulate them methodically. Many of the problems involve elaborate technical study; but their fundamental aspects are within the capacity of any reliable observer. All who love their country can find here valuable and congenial work for which the need is urgent.

The number of people in any district likely to join, and work with, a scientific society is small. But the study of natural or human history should develop a philosophical outlook that can supply a tonic for the world, and mitigate the attacks of the flesh and the devil. The mere existence of a body of people that declares its interest in matters bigger than political squabbles, preferring wider vistas than those of the daily headline, should ensure a nucleus of stability in the quicksands of suspicion and opportunism where civilization is floundering.

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meeting in an east-Midland town, when the question of dental service for expectant and nursing mothers was raised, a member declared that the husbands required treatment rather than the wives. The belief in the power of the caul to confer protection and good luck is gradually dying out, but at one time cauls were carried by the shore fishermen all along the coast of eastern England to protect them from death by drowning. In addition to the criminal use of savin and pennyroyal for abortifacient purposes, the legitimate employment of herbal remedies, especially raspberry tea, is widely spread in the eastern counties and north-east London for relieving the many inconveniences and minor troubles of pregnancy.

Ultra-Violet Lighting

MR. R. H. FINCH of the Lighting Section of the British Thomson-Houston Co. Ltd., has written a paper published in the *Electrical Review* for August 25 on the use in generating stations in war-time of ultra-violet lighting. The whole station could be bathed in ultra-violet energy and light produced only where needed, as, for example, on the handles of switches, meter scales, push buttons, telephones, doors, keyholes, tables, stairs, fire-extinguishers, etc., by the application to them of a dab of fluorescent paint or dye. Small press buttons should be surrounded by circles. Fuse positions can be delineated by outlining them, or by spotting the carriers with paint on the floor. In front of every switchboard a line should be painted about 12 inches away. The shape of every obstruction near an open switchboard or in a control room should be delineated by floor lines or patches of paint. Fluorescent chalks are also available for writing emergency warnings. The waves given off by the black lamps used are of a definite wave-length and produce no sun-burning or other dangerous effects. They are used in connexion with invisible fluorescent laundry marking systems and have been in constant operation for several years without a single case of ill effects to operators. Ultra-violet lighting is recommended for the emergency lighting in generating stations and similar premises in the Home Office A.R.P. Department pamphlet entitled 'War Time Lighting Restrictions for Industrial and Commercial Premises'.

African Linguistics

THE International Institute of African Languages and Cultures publishes in the July number of *Africa* a survey of linguistic questions relating to Africa, which includes a number of tasks with which the Institute is concerned. The issue by the Institute of a "Short Guide to the Recording of African Languages" has produced results of no little importance in their bearing on the study and classification of African languages. Prof. D. Westerman has compiled a list of no less than thirty-one previously and little-known languages which have been recorded through its use. This material has been sent to the Institute. Some will be published; the remainder, with such additional linguistic material as may accrue from time to time, will be available at the Institute for consultation by students. A valuable indication of the linguistic work already done, and of the field still to be covered in this department of investigation in Negro Africa, will be afforded by a series of articles which is to appear in *Africa*. The first in the current issue is a survey by Dr. Johannes Lukas of linguistic research between the Nile and Lake Chad. In addition to pointing out the regions to which future research can most usefully be directed, the series will serve as a preliminary classification of African languages. An interesting problem is discussed by Prof. C. M. Doke, who deals with the position and relation of European and Bantu languages in South Africa. While he admits that owing to political and economic factors European languages, and especially English, are ousting Bantu, he maintains that certain of the Bantu languages will persist for their cultural value in literary development and their private, family, and devotional use. Other contributions to this issue of *Africa* deal with indigenous literature, the study of intonation and of phonetics, and the facilities for the study of African languages in Great Britain, on the Continent and in South Africa. Consideration of the relation between language study and anthropology is reserved for future consideration.

Why Smallpox?

IN an editorial so entitled in *Public Health Reports* of June 23, it is stated that the United States leads all the other nations in the world except India in the number of smallpox cases reported in 1937, when there were 11,673 cases in that country. In 1938 the disease was more prevalent than it has been during the past five years, the number of cases being approximately 15,000. In 1936, according to the Health Section of the League of Nations, England and Wales, with a population of 40,839,000, reported only 12 cases. France, with 41,906,000 inhabitants, reported 273 cases, and Germany with a population of 67,346,000 had no cases. Some of the States in the Union have had no smallpox for several years. New Jersey, for example, with a population of about 4,400,000, has not had a case for more than seven years, while the States of North Dakota, South Dakota, Montana, Idaho, Oregon, Wyoming and Utah, with a combined population less than that of New Jersey, reported a total of more than 12,000 cases during the same period. The persistence of smallpox in the United States is simply due to neglect of vaccination, the explanation though not excuse for this being the comparative mildness of the disease in recent years and the reduced incidence compared with fifteen or twenty years ago. The possibility of the malignant type developing from the mild type is a disputed question, but there is always the possibility of the malignant type being introduced from foreign countries, especially in these days of air travel.

Olfactory Electricity

IT is stated in the *Beama Journal* of July that electricity is now being used to measure a smell. Various electrical devices are used in everyday work to make measurements in the domain of sight, touch

and hearing and in some cases high accuracy can be obtained. We feel sure that if demand for a practical application of this device is sufficiently great it will develop into new applications just as photometry, telephony and television have developed. The first application is to measure leakage from gas mains. In this case a snout or 'trunk' is constructed of such a shape that it can conveniently be poked into crevices along the gas mains. The operator presses a button and if there is a leak a sample of the gas is inhaled quickly into a test chamber, where it flows over an electrically heated platinum wire and registers on the meter the percentage of gas present. We are told that the electric device can do something which the human nose cannot always do. It can tell infallibly the difference between town's gas and sewer gas.

U.S. Industrial Research Laboratories

A SIXTH edition has recently been issued of the valuable list prepared by the National Research Council of the Industrial Research Laboratories of the United States (Washington, D.C.: National Research Council. Pp. 270. Paper cover, 2.50 dollars; cloth, 3 dollars). It consists of an alphabetical directory of commercial companies in the United States which maintain research laboratories, and is compiled from information obtained in each case from the director of research of the laboratory concerned. In asking for this information, it was pointed out that laboratories concerned merely with routine testing should not be included, but it was left to the director of research to decide whether his laboratory came within this category or whether it could be said to conduct research. The present list comprises no less than 1,769 entries, each of which gives such data as officers-in-charge, address, fields of science or engineering represented, research activities, publications, co-operative research supported and number of personnel. Federal, State and municipal laboratories are not included, except the National Bureau of Standards, while those in educational institutions have been omitted unless they are directly supported by industry. Four indexes are provided: serial publications; geographical distribution; principal personnel; and subjects of research.

Spectrochimica Acta

IN May, Messrs. Springer of Berlin published the first number of *Spectrochimica Acta*, which is to be devoted to research in the domain of chemical spectral analysis (see NATURE, **143**, 468; 1939). The first number has 92 pages, 17 cm. × 25·5 cm., 82 of which are devoted to papers on changes of intensities in spectra of aluminium alloys (in German), quantitative analysis of solder, spelter, magnesium and aluminium alloys (in English), quantitative estimation of europium in samarium (in German), a new use of emission spectra in local spectro-analysis (in German), the use of the arc in spectro-analysis (in German). The remaining pages contain abstracts of papers published elsewhere prepared by more than forty specialists. The price of the number is 8.60 gold marks, which at the present rate of exchange is about 15*s.* and seems unduly high.

Land-Speed Record

THE water-speed record set up on August 19 by Sir Malcolm Campbell has quickly been followed by a new record for speed on land. Mr. John Cobb, of London, in his Railton Red Lion motor-car, at Bonneville Salt Flats, Utah, is reported to have reached an average speed of 368·85 m.p.h. over a measured mile. The previous record of 357·70 m.p.h. was set up over the same course last September by Captain G. E. T. Eyston.

Dundee and District

A NOTEWORTHY and welcome feature of the "Scientific Survey of Dundee and District", prepared for the Dundee meeting of the British Association (Dundee: B.A. Reception Room. 2*s.*) is the inclusion of a new and very fine geological map of the country around Dundee. When it is remembered that the last official geological maps of most of this area date from last century (Angus, 1884, and East Fife, 1889) and that the last semi-official map was that prepared for the 1912 meeting of the British Association in Dundee, the value of the new map will be at once realized. The map, although not an official publication, was prepared in the Scottish Office of H.M. Geological Survey, and inevitably shows many changes in mapping when compared with the 1912 edition. These changes are in the main due to the revision work of the Survey officers in the Fife coalfields and to the researches of independent workers, as Allan, Balsillie, Cumming, and Walker. Geologists generally will welcome this new map. It is a pity that it has been bound into the volume instead of inserted in a bound-in envelope. A certain lack of uniformity of treatment is obvious in the natural science sections of the survey. This is due no doubt to lack of space, though it is very unfortunate that no room was found for mention of the geologists from Lyell, Hugh Miller, and Geikie onwards, whose labours have elucidated the geological problems of this very interesting part of Britain.

Announcements

THE second International Congress of Eugenics will be held at Bucharest on September 25–30 under the presidency of Prof. C. I. Parhon.

A LEAFLET of instructions for the correct application of the Schafer method of artificial respiration has been issued by the Royal Life Saving Society, 8 Bayley Street, Bedford Square, W.C.1, where it can be obtained free of charge.

ERRATUM.—In Table 2 of the letter by Dr. L. Hahn and Prof. G. Hevesy entitled "Phosphatide Exchange between Plasma and Organs" published in NATURE of July 29, p. 204, the percentage of organ phosphatide synthesized by the intestinal mucosa and the stomach have been interchanged; they should read: intestinal mucosa, 10·0; stomach, 4·1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 446.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Measurement of Neutron Dose in Biological Experiments

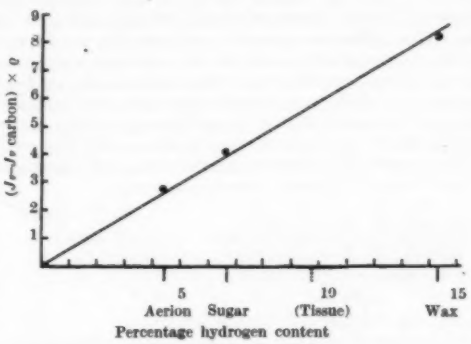
ZIMMER[1] has attempted an exact comparison of the absorbed neutron and gamma-ray energy required to produce an equal increase in the mutation rate in Drosophila sperm. In all other cases[2] neutron intensities have been measured in arbitrary units. In our own case[3] the unit dose was that amount of radiation which produced 1 E.S.U./c.c. of ionization in a graphite chamber having an air volume in the form of a disk 2 cm. diameter and 0·25 cm. deep. Taking as the unit of energy the increment of energy per unit volume of water subjected to 1 roentgen of gamma-radiation, we have now estimated the factor by means of which our arbitrary unit may be converted into energy absorbed per unit mass of tissue in three ways:

(1) The ionization produced by a beam of neutrons in free air has been calculated from the cross-sections for elastic recoil[4] and for nitrogen disintegration[5]. We estimate that 90 per cent of the recoil nuclei ionization and 40 per cent of the nitrogen disintegration ionization per c.c. of free air is measured by our graphite chamber. In addition there is the ionization due to the recoil carbon nuclei from the walls. This has been assessed in terms of the above mentioned data by comparing the ionization when the chamber was filled with pure oxygen with that when filled with air (0·71 : 1·0). A similar calculation gives the energy absorption in tissue ($H_2OC_{0\cdot1}$) and hence the conversion factor, which is found to be 7·3.*

(2) In the second method we avoided the use of collision cross-sections by comparing the ionization in the graphite chamber with that produced in chambers geometrically similar but with walls of 'Aerion'[1] ($C_6H_{4\cdot4}O_{1\cdot8}$), icing sugar ($CH_2O$), and paraffin wax ($CH_2$). Aerion and icing sugar are sufficiently conducting. The wax had a grid of graphite lines on it sufficient to produce a saturation field for gamma-ray ionization. As we were not confident that there would also be saturation for ionization by recoil nuclei the measurements were repeated with the wax covered with thinnest gold foil. The two sets were compatible and convinced us that the wax chamber results were reliable. Unit ionization in the graphite chamber corresponded to 3·35, 4·35, and 6·50 E.S.U./c.c. in the Aerion, sugar, and wax chambers respectively. It can easily be shown[6] that if J_v is the ionization per unit volume, W the average energy expended in the formation of a pair of ions in the gas, N the number of neutrons incident per square cm., n the number of gas atoms per c.c., σ_i the collision cross-section for atoms of type i, f_i the fraction of atoms of type i in the wall, $\overline{E}_i$ the average energy transferred from a neutron to a recoiling nucleus of type i, ρ_i the ratio of the mean atomic stopping power of the wall to that of the gas for recoil nuclei of type i, then:

$$J_v W = Nn\left[\Sigma_i \frac{f_i\ \sigma_i\ \overline{E}_i\ \varphi_i}{\rho_i} + \sigma_a\ \overline{E}_a\ \varphi_a\right],$$

where φ is a fraction, depending on the dimensions of the chamber and the effective range of the recoil nucleus, which approaches unity when the range is great, as is the case with recoil protons which are responsible for the majority of the ionization in chambers of wall material rich in hydrogen. φ may be calculated with sufficient accuracy in other cases. σ_a, $\overline{E}_a$ and φ_a refer to gas atoms.



DEPENDENCE OF NEUTRON IONIZATION ON THE HYDROGEN CONTENT OF THE WALL MATERIAL.

Since the hydrogen recoil term is very much greater than that for carbon recoils, J_v multiplied by the stopping power of the wall material for protons would be expected to increase very nearly linearly with the hydrogen content of the walls and this was in fact observed (see accompanying graph). Applying the above equation to the five sets of data—graphite-air $J_v = 1{\cdot}0$, graphite-oxygen 0·71, Aerion-air 3·35, sugar-air 4·35 and wax-air 6·50, we estimated the values of $N\sigma_i\overline{E}_i$ for hydrogen, oxygen, and carbon, and hence the energy absorption per c.c. of tissue, which is $N[n_H\sigma_H\overline{E}_H + n_o\sigma_o\overline{E}_o + n_c\sigma_c\overline{E}_c]$. The conversion factor is thus found to be 6·4.

(3) Finally, all calculated constants may be eliminated by filling the chambers with mixtures chosen from hydrogen, carbon monoxide, and acetylene, so as to have the same atomic composition as the walls; since φ and ρ are then exactly unity

* Our former estimate of the factor 11·5 ignored the contribution from the disintegration of nitrogen and assumed somewhat different values for interaction cross-sections.

and the equation becomes

$$J_v\overline{W} = Nn_g\,[f_H\sigma_H\overline{E}_H + f_o\sigma_o\overline{E}_o + f_c\sigma_c\overline{E}_c],$$

where n_g is the number of gas atoms per c.c. $\overline{W}$, the mean value of W for the gas mixture, was determined experimentally, relative to air, by means of gamma-rays. Measurements with Aerion, sugar, and wax would completely determine the three terms $\sigma_H\overline{E}_H$, $\sigma_o\overline{E}_o$ and $\sigma_c\overline{E}_c$. Unfortunately the 'sugar gas' measurements were not satisfactory—possibly on account of chemical action between the carbon monoxide and hydrogen under the influence of ionization—and so collision cross-sections were invoked for the *ratio* of the two small terms $\sigma_o\overline{E}_o$ and $\sigma_c\overline{E}_c$. The factor, determined in this way, was 6·9.

The three methods show satisfactory consistency, and suggest that a neutron beam which produces 1 E.S.U./c.c. of ionization in our graphite chamber will give the same energy absorption per c.c. of tissue as 7 roentgens of gamma-rays (± 20 per cent).

While the procedure which we have outlined is of general applicability, the particular value of the conversion factor is peculiar to a graphite chamber of the given dimensions, and to neutrons of about 3 Mev. energy. Comparison with Zimmer's results is, however, possible, since, through the courtesy of the German Cancer Campaign, the Aerion chambers used here were those used by Zimmer for Li-D neutrons. Dividing our factor of 7 by our observed ratio of neutron ionizations in Aerion and graphite, we obtain 2·1 as the figure by which the ionization in the Aerion chamber must be multiplied to obtain energy absorbed in tissue. Zimmer estimated this factor to be 1·8. The difference may in part be due to experimental error and in part to the different energy of the neutrons. Interaction cross-sections have been reported to show a marked dependence on neutron energy[7,8]. At the present stage of neutron dosimetry, the agreement must be regarded as satisfactory.

We gratefully acknowledge the financial assistance of the British Empire Cancer Campaign.

L. H. GRAY.
J. READ.

The Mount Vernon Hospital and the Radium Institute, Northwood, Middlesex. July 29.

[1] Zimmer, *Str. Th.*, **63**, 517; **63**, 528 (1938).
[2] The conversion of the American neutron results to absolute energy units is at present under investigation by Aebersold.
[3] Spear, Gray and Read, NATURE **142**, 1074 (1938).
[4] Kikuchi and Aoki, *Phys. Rev.*, **55**, 108 (1939).
[5] Baldinger and Huber, NATURE, **143**, 894 (1939).
[6] Gray, *Proc. Roy. Soc.*, A, **153**, 578 (1936).
[7] Salant, Roberts and Wang, *Phys. Rev.*, **55**, 984 (1939).
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Microcalorimetric Measurement of the Mean Energy of Disintegration of Radium E

THE mean energy of the β-rays from radium E can be evaluated either by integration of the continuous spectrum of the electrons emitted by the source or by a calorimetric measurement. The calorimetric method permits the determination of the energy of the electrons independently of the secondary processes which take place while they are going through matter, and furthermore with practically the same precision for both slow and fast particles. It is, on the other hand, necessary to know for a given source the number of atoms which disintegrate per second and also the number of electrons emitted by each disintegrating atom.

Two calorimetric determinations of the energy of disintegration of radium E have been made earlier; one is due to Ellis and Wooster[1], the other to Meitner and Orthmann[2]. Their results are only accurate to within 10 and even 15 per cent.

We decided to repeat these experiments owing to the fact that the Radium Institute in Paris could provide us with strong radium E sources and also because we could measure the absolute value of the polonium content with a very great precision. Furthermore, one of us had perfected considerably the technique of calorimetric measurements in radioactivity[3]. These improvements resulted from the adaptation of Swietoslawski's adiabatic microcalorimeter[4]. The principle of this calorimeter is as follows: with the help of a thermocouple, one maintains the same temperature in the calorimeter and in its surrounding water insulation, with a difference never exceeding a few ten-thousandths of a degree; the heat given out during the experiment is measured in such conditions by the increase in temperature of the water tank.

In our experiments the calorimeter was a nickel cylinder weighing about 10 gm., inside which the radioactive sample was placed in such a way as to allow no β-rays to come through before being absorbed by more than 3–4 mm. of nickel. The calorimetric capacity was tested by the measurement of the heat given out by a strong source of polonium (2,000–4,000 E.S.U.) deposited on a nickel foil, as was done with the radium E. This polonium source was measured with a precision of 1 or 2 per cent with the absolute apparatus of Mme. P. Curie[5].

The quantity x of polonium existing in the radium E sources at the beginning of the experiments was measured in the same way after deflecting all the β-rays by a strong magnetic field. This quantity, about 50–300 E.S.U., being at the limit of the sensibility of the apparatus, the precision of measurement is very small. Furthermore, the absorption of the alpha-rays by the radioactive deposit is very often not negligible. An evaluation of this absorption was made at the end of the experiments (when radium E has practically disappeared) by comparing the quantity of polonium determined by the calorimeter with that found electrometrically. Finally, in each set of experiments, x was evaluated within an accuracy of 10 per cent, which does not affect much the precision of the final results owing to the fact that our radium E sources were more than 40 mc. strong. The calorimetric measurement of the polonium at the end of the experiments allows us to evaluate at the same time, within 1 or 2 per cent, the quantity of radium E present at the beginning.

We made two sets of measurements: the first with a source of 80 mc. of radium E electrolytically deposited on a nickel foil (x = 55 E.S.U.); the second with 45·5 mc. of radium E deposited by evaporation in argon (x = 270 E.S.U.). In the second set, the calorimeter was filled with nitrogen in order to eliminate any possible influence of chemical reactions due to the presence of oxygen.

In each set of experiments the measurements made in the first 36 hours give values which are systematically too high. The measurements made in air (mean value: 323·6 ± 3·5 ekv.) are also slightly higher than those made in nitrogen (mean value: 317·6 ± 2·5 ekv.) and less coherent. The mean energy of

disintegration of radium E deduced from our measurement is 320,000 ± 5·000 ev. The most probable value is rather near the inferior limit given by our results.

The detailed description of our experiments will be given elsewhere.

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Thickness of Built-up Films

THE thickness of films built up on solid surfaces has formerly been measured by several methods: optically[1,2,3,4], by X-ray measurements[5,6], by the use of an interferometer[6], and directly with a screw-micrometer[6]. All these, except one modification of the first, required the deposition of some hundreds of layers, and the modification[4] involved a comparison with barium stearate films. During our investigation of protein films on solid surfaces, we have used a method which avoids this comparison and enables thicknesses of as little as 20 A. to be measured rapidly and accurately.

For a thin film on a metal surface the difference of optical path between the ray reflected from the film surface and that from the film metal interface is $d = 2\mu.e \cos\theta$, where μ is the refractive index of the film, e the thickness, and θ the angle of refraction. For minimum intensity of reflection, d must equal an odd number of half wave-lengths, that is, $4\mu.e \cos\theta = (2n+1)\lambda$, where n is any integer. Instead of keeping the wave-length, λ, constant and increasing e until two intensity minima are observed[1,3], we have measured the change in λ necessary to preserve an intensity minimum as the thickness of the film is increased by the addition of further monolayers.

The wave-length of the light which gives an intensity minimum for a given film-thickness was determined by means of a Hilger-Nutting spectrophotometer. This instrument is well suited for such measurements, since the monochromator enables any visible wave-length to be used for the photometric measurement, and the light reflected from the plates is polarized before passing through the spectrophotometer. Measurements must be carried out with the ordinary ray owing to the birefringence of the film. The accuracy of the method was tested with films of barium stearate deposited on stainless steel plates by the method described by Blodgett[1]. Measurements were made on films of ten or twelve monolayers deposited on a base of approximately forty stearate layers. The thick base is essential in order to bring the wave-length for minimum intensity into the visible region. Column *A* below gives the wave-length in angströms for the intensity minimum of the base, *B* the number of monolayers deposited on the base, and *C* the new wave-length for an intensity minimum. The light was incident at 75°.

A	*B*	*C*	*D*
5550	10	6650	24·2
4990	12	6310	24·2
5080	10	6160	23·8

Column *D* gives the thickness in angströms per layer, *t*, calculated from the equation, $t = \Delta\lambda/(4\mu \cos\theta.\Delta N)$, where $\Delta\lambda$ is the wave-length increment, μ the refractive index[2], taken as 1·491, θ the angle of refraction, and ΔN the number of additional layers deposited. The validity of the method is established by the agreement of the calculated mean thickness of 24·1 A. for barium stearate with the value 24·2–24·4 A. obtained by other methods.

Further details, with the results obtained for protein films, will be published elsewhere.

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Kepler's Law of Refraction

IN his review of the second volume of the new edition of Kepler's works in NATURE of August 19, p. 306, Prof. H. C. Plummer states that Kepler's formula for the law of refraction is

$$\alpha - \beta = k\alpha \sec\beta,$$

where α is the angle of incidence and β the angle of refraction. This reduces to the law

$$\sin\alpha = n \sin\beta$$

for small angles if $(1-k)^{-1} = n$. Prof. Plummer also states that as the formula is really empirical, being founded on the flimsiest physical argument, it seems strange that a form so inconvenient for the derivation of β from α should have been adopted.

The following table which I published fourteen years ago in the *Notes of the Edinburgh Mathematical Society* may be of interest in this connexion:

α	β Vitellio's observations	Excess of β calculated by Kepler's formula over Vitellio's observations	Excess of β calculated by modern formula over Vitellio's observations
10°	7° 45′	− 11′	− 16′
20°	15° 30′	− 29′	− 39′
30°	22° 30′	− 19′	− 28′
40°	29° 0′	+ 2′	− 10′
50°	35° 10′	+ 14′	+ 4′
60°	40° 30′	+ 22′	+ 1′
70°	45° 30′	+ 19′	− 41′
80°	50° 0′	+ 0′	− 2° 22′

The first two columns give Vitellio's observations on air-water. The third gives the excess of β over Vitellio's observations calculated by Kepler's formula for $n = 1{\cdot}317$ and the fourth the excess of β over Vitellio's observations calculated by the modern formula for $n = 1{\cdot}333$. It will be seen that Kepler's formula agrees much better with the observations than the modern one does, owing to the last experimental value being very far out.

The result, of course, bears out the statements made in the previous paragraph of the review, that Kepler was no experimental physicist and that the experimental data at his command were incredibly slight.

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Mechanism of Nitrogen Excitation in the Night Sky

THE light emitted by the night sky is a remarkable afterglow associated with recombination of atomic oxygen in the upper atmosphere[1]. Two normal atoms of oxygen could not recombine with emission of light; the recombination occurs only in presence of a third body to satisfy the principles of conservation. If that third body is an oxygen atom ^3P, it can attain the level ^1S by the following process:

$$O(^3P) + O(^3P) + O(^3P) \rightarrow O_2(X, v = 5) + O(^1S).$$

The total energy absorbed by the vibrations of the molecule and by the excitation of the atom (0·93 + 4·18 = 5·11 volts) agrees closely with the energy supplied by the recombination. Thus can be explained the emission of lines λλ 5577–6300 by the night sky. But if the third body is a nitrogen molecule in the normal state, the available 5·09 volts is insufficient to excite it, and we have to consider the three-body collision:

$$O(^3P) + O(^1D) + N_2(X) \rightarrow O_2(X, v_2) + N_2(A, v_2).$$

In such a collision the energy made available is $D = 7{\cdot}05$ volts; hence the possibility must be considered of emission of Vegard-Kaplan bands $N_2(A \rightarrow X)$. Only those bands the upper level of which does not exceed 7·05 volts will be emitted, and the corresponding quantum number v_2 is at most equal to 5.

Now the upper energy levels of the most intense Vegard-Kaplan bands are $v_2 = 2$ and $v_2 = 3$. To find the cause of this selection, we must consider the vibration of the oxygen molecule after collision. To bring the O_2 molecule to the v_2 level, E_1 volts are necessary; and we have at our disposal only the difference $D - E_1$ for the N_2 molecule. Consider the necessary energy $A + E_2$ to excite the nitrogen molecule to the A state with the vibration quantum number v_2. We can admit that the excitation does not occur unless the available energy $D - E_1$ and the required energy $A + E_2$ are very close, calling in a resonance effect. The following table gives, on this hypothesis, the probability of emission of the Vegard-Kaplan bands.

	Energy available		Energy required		Difference
I	$v_1 = 0$	$D - E_1 = 7{\cdot}05$ volts	$v_2 = 5$	$A + E_2 = 6{\cdot}99$ volts	+0·06
II	1	6·89	4	6·83	+0·06
III	2	6·67	3	6·66	+0·01
IV	3	6·48	2	6·49	−0·01
V	4	6·30	1	6·32	−0·02
VI	5	6·12	0	6·14	−0·02

The transitions III and IV should be the most probable, thus explaining the intensity of the Vegard-Kaplan bands $v_2 = 3$ and $v_2 = 2$ in the spectrum of the night sky.

The probability of a collision of the second kind has been studied for a long while. It is granted that the probability increases as the difference between the exchanged energies decreases. Kaplan[2] quotes, in confirmation of this, the experiments of Bonhoeffer and Mohler on the fluorescence sensitized by atomic hydrogen. Following Kaplan, the formation of a molecule H_2 on vibration level v_1 requires a triple collision with a metallic atom capable of absorbing very exactly the liberated energy $D - E_1$ ($D = 4{\cdot}34$ volts). Whence the possibility of emission from certain atoms (Na, K, Cd), whilst others (Zn, Mg) do not emit light.

Unfortunately the value of the dissociation potential of hydrogen accepted to-day is no longer 4·34, but 4·46 volts, and the coincidences that Kaplan thought he observed have disappeared. Also Kaplan has not apparently considered the rotation of hydrogen molecules. The total energy absorbed by a molecule is $E = E_v + B_v J(J + 1)$, where J designates the rotation quantum number. It would be sufficient, for the excitation of metallic atom to occur, that the required energy should be very near one of the possible values of $D - E$. But we multiply thus the theoretical possibilities of excitation, and metallic atoms, such as Zn or Mg, which have given nothing in the experiments quoted above, ought to emit the resonance radiation. The resonance potential of Zn is equal to 4·01 volts; that of Mg is 2·70 volts. Now, in the formation of a molecule H_2 ($v = 2$, $J = 7$), the liberated energy is 4·05 volts; it is 2·75 volts in the formation of a molecule H_2 ($v = 3$, $J = 7$). But perhaps the differences 4·05–4·01 = 0·04 and 2·75–2·70 = 0·05 volts are already too large to show excitation.

However, we observe also in the night sky spectrum a selection of the bands of the first positive system of nitrogen. The band λλ 6500–6550 emitted in the transition $B\,(v = 7) \rightarrow A\,(v = 4)$ is much the most intense. Now the excitation of the normal nitrogen molecule on the level $B\,(v = 7)$ requires 8·71 volts, an energy which we do not find in the night sky. We must therefore consider the two consecutive transitions $X\,(v = 0) \rightarrow A\,(v = 2)$ and $A\,(v = 2) \rightarrow B\,(v = 7)$. The second absorbs 2·22 volts, which is only a little less than the 2·23 volts supplied by the O (^1S) atom in returning to the ^1D level. We can thus explain the enhancement of the 6500–6550 band in the sky by collision of the nitrogen $A(v = 2)$ molecules and oxygen ^1S atoms. In these collisions, the absorbed energy is equal (at about 0·01 volt) to the available energy.

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[1] Chapman, *Phil. Mag.*, **10**, 369 (1930) and **23**, 657 (1937).
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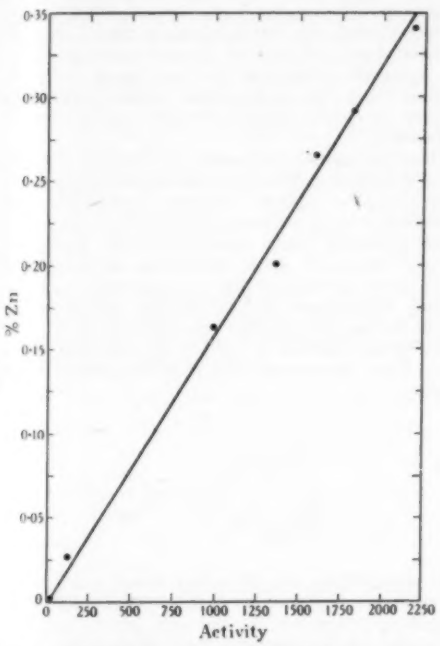
Carbonic Anhydrase

IT was shown by Henriques[1] that the rate at which carbon dioxide is evolved in the reaction $H_2CO_3 \rightleftharpoons CO_2 + H_2O$ is greatly accelerated by the presence of laked blood, mere traces of which are sufficient to catalyse this reaction[2]. That this acceleration is not due to hæmoglobin was clearly demonstrated by Meldrum and Roughton[3,4] who have separated from the red blood corpuscles a new enzyme capable of catalysing both phases of the above reaction. They described this enzyme under the name of carbonic anhydrase and gave a detailed account of its properties. Their purified preparation of this enzyme was a colourless substance, very active and sensitive to KCN, H_2S and NaN_3. The amount of this enzyme-preparation was, however, very small and scarcely sufficient even to recognize it with certainty as a protein compound. In the course of our study of metallo-protein compounds[5] present in the red blood corpuscles, we have found that the fractions of our preparations left after the complete removal of hæmocuprein had a very high content of zinc and a high carbonic anhydrase activity. By adapting our methods of purification to preparations on larger

scale, such as 10 litres of blood at a time, and taking special care to increase the yield of the zinc fraction, we have obtained a highly active preparation of carbonic anhydrase. The activities of different fractions have been tested both by the manometric 'boat' method[3] and the colorimetric method[4]. The zinc in different fractions was determined by the dithizone and by the iodometric ferricyanide methods and was also isolated as a crystalline zinc quinaldinat salt.



RELATIONSHIP BETWEEN ACTIVITIES (AS DEFINED BY MELDRUM AND ROUGHTON[2]) AND ZINC CONTENTS OF DIFFERENT FRACTIONS OF CARBONIC ANHYDRASE.

From carefully washed corpuscles of 10 litres of ox blood, which give about 17 litres of alcohol chloroform extract, we have obtained about 250 mgm. of colourless protein containing 14·95 per cent nitrogen and 0·31–0·34 per cent zinc and showing a high carbonic anhydrase activity. This preparation tested chemically was found to be almost completely free of other metals known to occur in blood, such as iron, copper, manganese or magnesium. Moreover, the spectrum analysis of such preparations kindly carried out by Prof. H. Dingle confirmed the above results and revealed only traces of other metals. The fact that its zinc content has already reached such a high value shows that this preparation contains probably only one protein compound. The very high carbonic anhydrase activity of this preparation suggests, therefore, that the enzyme is the zinc-protein compound. This is, moreover, supported by three other considerations, namely: (1) the parallelism between the carbonic anhydrase activities and zinc contents in different fractions, at least up to our purest preparation (see accompanying illustration); (2) the perfectly reversible inhibition of the enzyme activity by KCN, H_2S and NaN_3 which are known as specific inhibitors of reactions catalysed by metallic compounds; (3) the absence of other metals in the highly active preparations of carbonic anhydrase.

By comparing the catalytic activity and the zinc content of our purest preparation with those of the laked red blood corpuscles, it appears that the total zinc present in the corpuscles belongs to the zinc-protein compound of carbonic anhydrase.

It may be mentioned finally that zinc belongs to the universally distributed micro-constituents of plants and animals and is therefore much more widely distributed in Nature than carbonic anhydrase. Like iron and copper, zinc forms probably with different proteins several compounds having different properties and functions.

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Artificial Hibernation

As I have already shown in preliminary communications[1,2], artificial hibernation is produced in hedgehogs in autumn by giving them injections of magnesium simultaneously with insulin and transferring the animals to an ice-box. Thereby, for example, the heat regulation of the animals was disturbed, and they passed from a warm-blooded state into a cold-blooded one. At the same time, the blood sugar value was decreased to the level of that found in normal hibernation. In the first series of experiments I employed comparatively large amounts of magnesium and insulin. Similar amounts of insulin given without magnesium always caused fatal hypoglycæmia.

This summer I have continued the experiments with more material. The experiments have been carried out with fully awake hedgehogs at the end of June and at the beginning of July. Artificial hibernation was produced in these experiments in midsummer by administering to the hedgehogs subcutaneous injections of magnesium simultaneously with insulin and transferring the animals into an ice-box (at + 2 — 5° C.). The amounts injected were much smaller than those used in autumn (usually 0·5 c.c. 1 mol. magnesium chloride and 4 I.U. insulin per 480–750 gm. body weight). The same amount of magnesium only and cold had no effect on the animals; but on the other hand, the same amount of insulin only and cold caused the hedgehogs to go into artificial hibernation. Laufberger[3], Dworkin and Finney[4], and Dische, Fleischmann and Trevani[5] have also produced artificial hibernation with insulin injections. Especially noteworthy is the considerable increase of serum magnesium in the hibernation brought about by insulin, as in the natural hibernation[6,1].

	Blood sugar (mgm. %)	Serum Mg (mgm. %)	Serum Ca (mgm. %)
Normal hedgehog	109	2·5	11·4
Artificial insulin hibernation	38	4·4	11·0
Natural deep hibernation	49	6·1	10·6

The hedgehogs have remained hitherto in the artificial hibernation continuously for 10 days

When the animals in which hibernation was induced with both magnesium and insulin or with insulin alone were removed from the ice-box to a warm temperature (21 – 23° C.) they awoke in a natural manner and returned again to the warm-blooded state.

A more detailed account of the investigations will appear in the near future.

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Mesomerism and Orientation

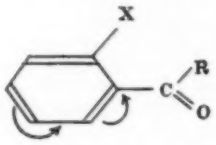
THE brief reference to the apparently anomalous nitration of the acetyl derivative of 2-*m*-xylidine to a 4-nitro derivative and its interpretation in the paper just published by Ingham and Hampson[1] makes it desirable to point out that many of the anomalies associated with ortho-substituents (and usually grouped under the heading of 'ortho effects') find their explanation in the steric hindrance of resonance discussed by Ingham and Hampson. This view had been arrived at independently in connexion with a systematic study of isomerizations produced by aluminium chloride[2]. It is hoped to publish an account of the further development of this work in the near future, but meanwhile the following selected illustrations of the more general application of this view may be cited.

Steric incompatibility between an *o*-methyl or -methoxy group and a dimethylamino group is reflected in an enfeebled mesomeric relationship of the latter group with the nucleus, as exhibited on one hand in a minimized tendency to *p*-substitution, for example, by nitrous acid, benzene diazonium chloride, formaldehyde, or benzaldehyde[3], and on the other, in predominating basicity of the *o*- over its *p*- and *m*-isomerides, which is in striking contrast with the relationships of the toluidines, their monoalkyl derivatives and 1.8 dimethyl 1.2.3.4 tetrahydroquinoline[4]. The abnormally slow alkaline hydrolysis of *o*- relative to *m*- and *p*-acettoluides[5] is similarly explained.

Reduced mesomerism of the carboxyl group is illustrated by enhanced acidity, greater activation energy of acid-catalysed esterification, and reduced activation energy of alkaline ester hydrolysis, in the case of *o*-toluic acid as compared with benzoic acid; *o*-tertiary butyl benzoic acid, again, is even stronger than *o*-toluic acid[6]. However, if a reaction involves orientations which are hindered by an *o*-substituent, this hindrance may partly reveal itself in an elevation of the activation energy representing an 'energy of orientation'. The conversion of 3-nitrophthalic acid into its 1-methyl ester by ordinary esterification, and of the anhydride into the 2-methyl ester by treatment with methyl alcohol[7] are interesting illustrations of the principle just discussed. *O*-tolylphenylchloromethane[8] shows, as expected, a greater 'ortho effect' than does *o*-methylbenzyl chloride[9] in acid hydrolysis. The phenyl boric acids[10] and the phenols[11] show no 'ortho effect' because hindered mesomerism is out of the question in each case owing to absence of mesomerism and steric orientation respectively.

In general, only monoketonic derivatives are produced from benzene and its homologues by the Friedel-Crafts reaction, yet di-*o*-alkyl substituted aryl ketones, and these alone, are amenable to further substitution under these conditions[12]. This is the more striking in view of the fact that mesityl methyl ketone combines exothermally with aluminium chloride; the consequent deactivation is, however, not transmissible to the nucleus owing to the steric conditions. The same factor may well be operative in determining the extraordinarily facile dinitration of mesitylene. Similarly, it must be expected that the *o*-nitrothiophenoxide ion is a more nucleophilic reagent than the *p*-isomeride, while *p*-nitrochlorobenzene is more reactive to such reagents than its *o*-isomeride.

There are numerous examples of carbonyl attached to an aromatic nucleus undergoing hydrolytic fission with acids[13]; almost without exception, an *o*-substituent is a necessary condition. This 'ortho effect' probably has a two-fold origin: (*a*) the previously discussed steric hindrance of mesomerism ($-T$) of the carbonyl group; and (*b*) steric promotion of the polarization in the nucleus which allows a displacement of a nuclear attached atom out of the plane of the nucleus to relieve the crowded orientation. Both these steric effects facilitate electrophilic attack.



In α-tetralone, on the other hand, the atoms in question are coplanar with the nucleus, and in consequence hydrolytic fission and inter- and intramolecular rearrangements with aluminium chloride are not observed.

Sterically enhanced nuclear polarizations no doubt facilitate such observed conversions as *iso*-durene and hexamethylbenzene into mesitylene with hydriodic acid[14]. The inter- and intra-molecular rearrangements brought about by aluminium chloride frequently find their origin in this twofold steric effect of *o*-substituents on mesomeric and electromeric effects.

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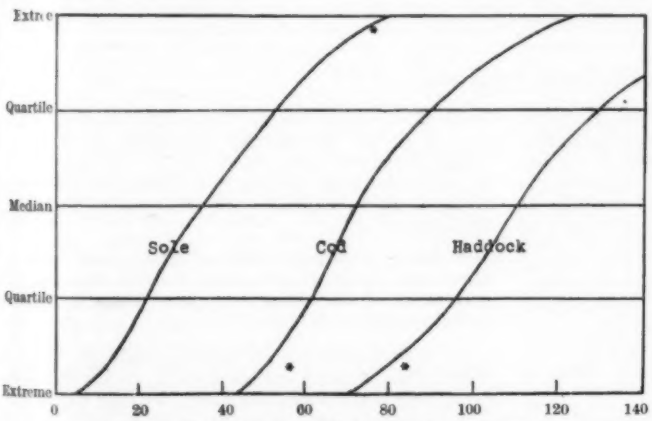
Fishery Statistics

WHEN we compare the catch of fish of one year with that of another, we find one greater or less than the other, and that seems at first sight the end of the matter. But if we analyse each year's total into its monthly parts we see in every case a certain seasonal periodicity; and it follows that we may expect to find not only differences of total quantity, but also of phase and amplitude, the two ways in which one periodic function differs from another. Let us reduce the monthly quantities to percentages of their annual totals, and then compare the periodicity of one year with another or with a mean. To show, briefly, how orderly and how instructive the rough market statistics are, let us merely compare one year's monthly data with another's:

ABERDEEN LANDINGS OF NORTH SEA PLAICE; MONTHLY PERCENTAGES OF ANNUAL CATCH

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1932 ..	7·7	9·5	8·4	9·0	7·9	8·7	7·4	9·4	9·7	9·3	7·2	4·9
1937 ..	3·3	3·6	3·9	6·2	6·8	7·7	9·2	14·5	17·5	11·4	8·8	7·1
Difference	4·4	5·9	4·5	3·7	1·1	1·0	−1·8	−5·1	−7·8	−2·1	−1·6	−2·2

The monthly discrepancies yield a nearly regular fluctuation, and show at a glance how the phase of the periodic function was accelerated in one year and retarded in the other.



NORTH SEA LANDINGS (ABERDEEN): 1912–37
*** Catches of 1937.

While writing on this point let me mention another, though it is no more than a statistical gadget; I think it is new, and Mr. Udny Yule says it is new to him. We want to compare, say, last year's catch with twenty previous years, and not in order of time but of mere quantity. We take, as usual, the extremes, quartiles and median of the series; we shall find these five points enough to draw, approximately, a curve of distribution of the whole. It will obviously be an S-shaped curve; and we may mark it with an asterisk to direct attention to a particular year. The annexed chart thus shows at a glance how 1937 was all but the worst year for cod and haddock, and all but the best year for soles, in six-and-twenty years.

D'ARCY W. THOMPSON.

University,
St. Andrews.
July 30.

Symphyogenetic Development

THERE has existed a need for a term to express the idea of the interaction of hereditary and environmental factors in producing the development of an organism. It must be a term to signify that the organism is the resultant of the integration of the two sets of factors. It must convey the idea that has been almost universally accepted by writers in the field of development that the organism is always 'becoming something' and 'tending somewhither', because it is a result of an interrelation between an environmental milieu and hereditary potentialities which together constitute the necessary materials and conditions to produce a living thing through their interaction. The term *symphyogenetic development* seems to be suitable for expressing this idea.

Symphyogenetic is derived from the three Greek stems, σύν, meaning *with*, φύειν, meaning *to grow*, and γίγνεσθαι, meaning *to come into being* or *to be*. Literally, it conveys the idea of something coming into being and growing as a resultant of the interaction of two or more factors, and thereby undergoing development. The word symphyogenesis has had a previous usage. The "Century Dictionary and Cyclopedia" gives its meaning as follows, "In *bot.* the forming by union of previously separate elements". The "Webster's New International Dictionary" defines it thus, "*Bot.* Development of an organ by the union of previously distinct organs". The present proposed usage of symphyogenetic does not violate either of these definitions of symphyogenesis.

To define symphyogenetic in terms of its proposed use, where it is to be employed as a modifier of development, it would mean, *the combining of hereditary determiners and environmental factors to produce the characteristics manifested in an organism's structure and behaviour*. Symphyogenetic development would be used in contrast to maturational development, which emphasizes the ordering of the hereditary determiners for producing the sequential regularity of development, other things being equal. Its usage would be in contrast to epigenetic development, which emphasizes the production of differentiations in development as a result of the influence of environmental factors acting upon a relatively simple structure in the beginning. Obviously it is in contrast with the ancient idea of preformism.

WILTON P. CHASE.

Women's College,
University of North Carolina,
Greensboro.
July 17.

Skin Cancer due to Handling Coal Tars Used for Preservation of Fishing Nets

COMPLAINTS that several fishermen had contracted cancer of the skin after handling tar used for the preservation of nets resulted in an interested firm submitting a sample of their tar to this department to investigate its carcinogenic effect on mice. This particular tar (our No. 7) was said to have been manufactured in a horizontal retort at a temperature of 1100° C. It was found to be highly carcinogenic for the skin of mice, 75 out of 100 bearing malignant tumours after bi-weekly applications of the tar for forty weeks. This result compared very unfavourably with a number of tars, used for various purposes, previously tested by us.

Later, three further tars from the same firm were submitted to us for test: (1) our No. 14, made in a vertical retort at 1390° C.; (2) our No. 16, as before but said to be cut back with light tar oils; (3) our No. 15, said to have been made from oil pitch and light tar oils.

Results of animal experiments showed that Nos. 14 and 16 were almost as carcinogenic for mice as No. 7, but that No. 15 was considerably less carcinogenic, only 17 mice out of 100 contracting skin cancer after forty weeks, although twenty of the mice survived for this period.

Preliminary tests with samples of creosote oil and anthracene oil revealed that both are carcinogenic for the skin of mice.

In our opinion, if gas tar as such is used for preservation of fishing nets, only that made in vertical retorts using a temperature as low as practicable should be used.

J. M. TWORT.
R. LYTH.

Department of Cancer Research,
University, Manchester.
July 26.

The Garner Principle of Co-operative Activation

IN a letter in NATURE of August 12, p. 287, Prof. W. E. Garner has made, in my opinion, a most important contribution to the advancement of physico-chemical science. It seems probable that the Garner principle will be of great value in the understanding and formulation of many catalytic phenomena, including the interlinked sets of reactions which are now known to occur in the operation of many enzymes and co-enzymes.

F. G. DONNAN.

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Points from Foregoing Letters

L. H. Gray and J. Read, working on the biological effects of neutrons, have used the ionization produced in air in small graphite ionization chambers as a measure of neutron dose. Experiments have now been made which make it possible to correlate the ionization with the actual increment of energy per unit volume of tissue due to the recoil atoms generated by the neutrons. Calculations based on interaction cross-sections agree with two different lines of experimental investigation in showing that a neutron beam which produces 1 E.S.U./c.c. of ionization in a graphite chamber will give the same energy absorption per unit volume of tissue as 7 roentgens of γ-rays (20 per cent).

M. Lecoin and I. Zlotowski have measured very carefully with an adiabatic microcalorimeter the mean energy of disintegration of radium E. They obtain the value 320,000 $\pm$ 5·000 ev., and the lower limit is regarded as very near the most probable value.

G. I. Jenkins and A. Norris describe a new method of measuring the thickness of built-up films on metal by finding the wave-length at which minimum intensity of reflected light occurs at constant angle of incidence. The method makes possible a measurement of the thickness of very small numbers of layers and seems especially promising in the field of protein investigation for which it was devised.

Surprise has often been expressed that Kepler failed to find the true law of refraction. R. A. Houstoun shows that Kepler's formula satisfies the observations that were available to him better than the modern formula does.

The spectrum of the N_2 molecule in the light of the night sky is well known to-day. The upper energy level of the most intense Vegard-Kaplan bands are $v = 2$ or 3; among the red bands of the first positive system, the band $B(v = 7) \rightarrow A(v = 4)$ is much the most intense. J. Cabannes and Rose Aynard try to explain that selection by resonance phenomena.

Evidence is brought forward by D. Keilin and T. Mann that carbonic anhydrase isolated from the red corpuscles of ox blood in a pure state is a zinc-protein compound.

P. Suomalainen has previously produced artificial hibernation by injecting magnesium and insulin into hedgehogs and transferring them into cold conditions. The quantities used, however, were so large that an equal amount of insulin alone killed the animals. The author has now decreased the amounts of injections, and artificial hibernation is brought about with insulin only and cold. Serum magnesium is considerably increased in the insulin hibernation, as in the natural hibernation.

G. Baddeley shows that the more general application of sterically hindered mesomerism is illustrated by strengths of acids and bases, velocities of side-chain reactions and nuclear substitutions, and by the hydrolytic fission of carbonyl attached to an aromatic nucleus. Steric promotion of nuclear polarizations is also considered a factor contributing to the 'ortho effect'.

Sir D'Arcy W. Thompson suggests that, as the catch of fish is a periodic phenomenon, it should be both useful and easy to take note of differences between one year and another in phase and amplitude as well as in the annual total. A new form of statistical chart is also suggested.

RESEARCH ITEMS

Cranial Deformation among the Ancient Maya

Two cases of artificial deformation of a remarkable and unusual character have been described by A. J. E. Cave (Smithsonian Institution, *Anthropological Papers, Bull.* **123**; 1939). They were derived from Maya mounds in the Corozal District of British Honduras excavated by the late T. W. Gann. The first specimen is the mutilated brachycephalic cranium of an elderly subject, probably female, which lacks almost the entire facial skeleton. It has an auricular height of 111 mm., a maximum length (glabella-inion) of 150 mm., a maximum (biparietal) breadth of 165 mm., a minimum frontal breadth of 92 mm., and a cephalic index of 110. The whole calvaria is fairly symmetrical; but it is curiously and quite artificially deformed. Mechanical flattening of the supra-inial occiput has produced an enormous lateral out-thrust of the cranium in the mid-parietal transverse axis. The frontal region has not been directly compressed and merely shares in the general lateral bulging of the whole skull. In each temporal fossa there is an obvious and artificial groove ascending over the alisphenoid and anterior portion of the parietal to be lost above the superior temporal crest. These grooves must be the product of tightly applied bandages. In norma verticalis the cranium suggests an abortive 'bilobed' appearance. The cranium is actually of greater breadth than length. The same condition appears in the second specimen—the calvaria of an adult, middle-aged subject, presumably male. It is imperfect, and also partially a restoration, but enough remains to show that despite deformation it was brachycephalic and of corresponding type to Specimen I. Its measurements are auricular height, 100 mm.; length, 154 mm.; breadth, 171 mm., min. frontal breadth, 101 mm., cephalic index, 111. Artificial deformity has been produced by pressure applied to the supra-inial portion of the occipital, and the hinder portion of both parietals, resulting in a squashing forward of the vault and an enormous exaggeration of the biparietal diameter, which exceeds the maximum length of the skull. Two artificial grooves indicate the application of bandages. Like Specimen I, this skull also shows a tendency to the bilobed condition.

Tuberculosis among Young Adults in England

WHILE the general death-rate from tuberculosis of the lungs has been steadily declining during the last 60–70 years, that for young men and women, aged 15–24 years, which followed the general trend during last century, has been almost stationary during this century. This set-back is particularly evident among young women, whose pulmonary tuberculosis death-rate per 100,000 fell from 276 to 112 in the thirty years between 1871–80 and 1901–03; but remained almost stationary in the next thirty years, being 107 in 1911–13 and again in 1931–33. This problem has been examined, so far as England is concerned, by P. D'Arcy Hart and G. Payling Wright, whose findings are set out in a recently issued report ("Tuberculosis and Social Conditions in England". National Association for the Prevention of Tuberculosis, London. Price 3*s*.). The phenomenon has been examined mainly in relation to social conditions, including general standard of living, housing, internal migration and volume of occupation. The retardation in decline of phthisis mortality has affected young women more severely than young men, and at present nearly half the deaths from all diseases among young women are due to phthisis. On the whole, urban areas are more seriously affected than rural districts. The unsatisfactory course of pulmonary tuberculosis among young adults seems to be due to a complex of factors. Unsatisfactory trends in the national standard of living, and the rapid industrialization of young women, appear to have played important parts, while bad local social conditions, in particular bad housing, have increased the effect in certain localities.

Anatomy of Apple Roots

THE possibility of predicting the performance of apple varieties on different rootstocks is brought nearer by the observation that vigour is correlated with certain anatomical features of the stock roots. A. B. Beakbane and E. C. Thompson (*J. Pom.*, **17**, 141; 1939) have examined sections of the roots of eighty-six four-year-old apple trees on Malling stocks VII and IX and on eight new clonal stocks worked with Lane's Prince Albert. A striking negative correlation was found between the relative area of bark to wood, as seen in transverse section, and the vigour of the scion. The percentage areas of fibres, vessels, rays and to a less extent, of parenchyma, estimated from photographic prints of sections, were found to be related to scion vigour. Vigorous rootstocks were found to have an almost equal amount of living and dead tissue, whereas the dwarfing stocks had twice to three times as much living as dead tissue, that is, more parenchyma and ray cells. The vigorous stocks had a larger number of vessels and nearly twice as many xylem fibres as the dwarfing stocks and there was a tendency for the vessels to be larger in the vigorous stocks. If the tendency thus observed persists in older trees, examination of internal structure may enable breeders to classify new rootstocks according to vigour without the lengthy field trials now necessary.

Spraying and Photosynthesis

THE application of a spray fluid for the control of insects or fungi has usually been regarded solely from the pathological point of view. R. A. Hyre has shown, however (Cornell Univ. Agr. Exp. Sta. Memoir 222, Ithaca, N.Y., April 1939), that certain sprays lower the photosynthesis of the plant to which they are applied. Lime-sulphur may even reduce it by as much as 28 per cent at ordinary summer temperatures, but Bordeaux mixture, on the other hand, has little effect. Emulsified sulphur pastes were found to be intermediate in their effect upon photosynthesis. Respiration was not markedly affected by spray fluids. Studies upon such factors as the biennial bearing of tree fruits show that these plants cannot sustain any considerable loss of photosynthesis with impunity. The loss in anabolism through spray applications is not of many days' duration but it is likely to occur at the critical time of flower bud formation, when the extent of the

subsequent year's crop is being determined. The use of Bordeaux mixture instead of lime-sulphur in the summer spray programme would provide a practical means for the achievement of pathological control without physiological disturbance.

Narcissus Mosaic

A LEAF-MOTTLING virus disease of narcissi has been known for some considerable time, but details of its etiology and physical properties have only recently appeared ("Studies on Narcissus Mosaic" by Frank A. Haasis, Cornell Univ. Agr. Exp. Sta. Memoir 224, Ithaca, N.Y., U.S.A., April 1939). Affected plants are stunted, they bear inferior bloom and produce poor bulbs. Their foliage and flower stems are mottled by yellow stripes, whilst the flowers are occasionally distorted and streaked with white, though symptoms vary with the variety. Transmission to a healthy plant can be effected by grafting a portion of a diseased bulb, by the normal vegetative propagation, and by various mechanical means, but neither by root contact nor through soil contamination. The virus appears to be of moderate virulence, its resistance to ageing *in vitro* is slight, it can withstand but little dilution and it is inactivated by a temperature between 70° and 75° C. Control presents the difficulties usually associated with virus diseases, and little can be done beyond the removal of infected plants, and the growth of selected stock within insect-free cages.

'Packet Velocity' of Dispersive Elastic Waves

K. Sezawa and K. Kanai have recently discussed this problem (*Bull. Earthq. Res. Inst., Tokyo*, **17**, Pt. 2, 208–232; 1939). The basis of the discussion was a wide range in wave-length of Rayleigh and Love waves which could be adapted to an extensive range of dispersion conditions of waves of irregular form. From a mathematical investigation of the chosen examples it was ascertained that even should the wave form be irregular, the energy of the waves was transmitted with a special group velocity. If the sinusoidal components composing the irregular waves had different group velocities, it appeared likely that the centroid of the wave energy, that is, the centroid of the energy of the wave packet, would be transmitted with the group velocity that corresponded to the waves of infinite length involved in the irregular waves. If the group velocity differed with difference in length of the sinusoidal waves, even should the disturbance be of sine form of finite extent, the centroid of the same disturbance was still transmitted with the group velocity of sinusoidal waves of infinite length. If the dispersion formula was of the form $c = A \pm Bf^s$, the centroid of a packet of irregular waves was transmitted with velocity A, that is, the group velocity of the longest possible waves composing the wave packet.

Fluidity and Temperature

A SIMPLE relation between fluidity (θ) and absolute temperature (T), namely, $\theta/T = a + bT + \ldots$, has been established by E. C. Bingham and S. D. Stookey (*J. Amer. Chem. Soc.*, **61**, 1625; 1939) for a large number of liquids, apparently failing only for alcohols. It has also been shown to apply to some types of solutions. It is found that the constant a is a function of the homologous series to which the compound belongs, and the constant b a function of the molecular weights of the members of the series, so that an equation may be obtained containing constants which are functions only of the series concerned, and not of individual members of the series, namely, $\theta/T = A_s + \alpha T 10^{(\beta/M - \gamma/M^2)}$, where M is the molecular weight and α, β and γ are constants. It is thus possible to calculate the viscosity of any member of a non-associated series up to ten carbon atoms at any temperature by means of only four constants.

Structure of Cyclo-Octatetrene

The evidence for the structure of 1,3,5,7-cyclo-octatetrene, discovered by Willstätter and Waser in 1911 and widely used in discussions concerning the structure of the aromatic nucleus, rests chiefly on its mode of synthesis from pseudo-pelletierine and on its hydrogenation to cyclo-octane. C. D. Hurd and L. R. Drake (*J. Amer. Chem. Soc.*, **61**, 1943; 1939) have now prepared both 1,2- and 2,3-butane-*bis*-(trimethylammonium) bromides from pure specimens of 1,2-dibromobutane and 2,3-dibromobutane. Pyrolysis of the *bis*-quaternary hydroxide from the 1,2-salt gave rise to ethylacetylene and methylallene, but no 1,3-butadiene. Pyrolysis of the *bis*-quaternary hydroxide from the 2,3-salt yielded 1,3-butadiene and methylallene (or methylallene and dimethylacetylene), the latter being slightly in excess of the 1,3-butadiene. The assumption of the former authors that conjugated unsaturation results exclusively during pyrolysis of a functional group in the quaternary hydroxide molecule is unjustified and the fact that 1,3-butadiene was not the exclusive product from 2,3-butane-*bis*-(trimethylammonium) hydroxide is regarded as casting serious doubt on the structure of Willstätter's cyclo-octatetrene and on the conclusions drawn from it.

A Possible Explanation of Very Slow Adsorption

IN a series of papers published during the last four years (*Curr. Sci.*, **4**, 405; **5**, 645; **6**, 446; **7**, 182; *Proc. Ind. Acad. Sci.*, **4**, 97; 1936: *Kolloid-Z.*, **84**, 138; 1938: **86**, 205; **87**, 272; 1939), K. S. Gururaja Doss describes further experiments showing that the rate of adsorption and lowering of surface tension, in aqueous solutions of various colloidal electrolytes, is frequently very slow. This slow accumulation at the surface, which had been previously observed with paraffin chain salts in dilute solution, is now explained as due to the existence of a potential energy barrier at the surface, caused by the electrostatic repulsion exerted by the electrolytically dissociated end groups of those molecules which first arrive at the surface, on the similarly charged end groups of other molecules attempting to diffuse to the surface. Only those molecules, therefore, which possess unusually large kinetic energy can pass this barrier; but once arrived at the surface, their hydrophobic portions retain them at the surface. To such molecules travelling towards the surface, an energy 'hump' must be surmounted, in order that the charged end group may pass through the diffuse double layer set up by the molecules first adsorbed; once this is passed, the molecules find an energy 'trough' at the surface, caused by the natural tendency of the hydrocarbon portions of molecules to cover the surface of water. Consequently a considerable energy of activation is likely to be required for the adsorption of molecules containing electrolytically dissociated end groups, and some hydrocarbon, in their constitution, and this may account for the slow adsorption.

FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

LIÈGE MEETING

IN response to the kind invitation of the University of Liège, the French Association for the Advancement of Science met during July 17–22 for the third time in Belgium; the previous meetings were at Liège in 1924 and at Brussels in 1932.

The International Water Exhibition at Liège which marked the inauguration of the Albert Canal gave the meeting a special interest. Prof. C. Fabry, president of the French Association, presided over the meeting, and Prof. Dehalu, *administrateur-inspecteur* of the University of Liège, was president of the local committee.

The opening ceremony took place on July 17 in the hall of the University. Prof. Dehalu expressed his pleasure at receiving the Association at Liège for the second time, and Senator Buisseret, speaking on behalf of the burgomaster, welcomed the members of the congress. Prof. C. D. Ellis, Wheatstone professor of physics at King's College, London, representing the British Association, and Dr. C. Romaña, representing the Argentine Association for the Advancement of Science, brought messages of good will for the success of the meeting. Prof. Fabry, after having expressed the thanks of the Association to the local committee at Liège, delivered his presidential address, on interstellar space.

Prof. Fabry showed how a profound study of the light of the stars has enabled us to detect, in interstellar space, matter in a state of extreme rarefaction (1 kgm. nearly in a volume equal to that of the earth). In addition to matter, there exists also in interstellar space energy in the form of radiation emitted by the stars. These results have demonstrated the fruitfulness of collaboration of diverse scientific disciplines and of pure and applied science. Such collaboration is also the object of the French Association and of similar bodies.

The scientific meetings were held in the magnificent Institutes of Civil Engineering and Chemistry of the University of Liège at Val Benoît on July 17 and the following days. July 19 was devoted to an excursion on the Albert Canal and to a visit to a colliery at Beeringen. July 21, the day of the national fête of Belgium, was taken up with a visit to the Water Exhibition.

The several sections of the Association showed great activity. The question of water occupied a prominent place in the programme, and was the subject of the following papers: M. Wyart, the states of solid and liquid water studied by X-rays; M. Cabannes, the Raman spectrum of liquid water; M. Kraft de la Saulx, history of the construction of hydraulic machines; M. Tongas, thermodynamic properties of steam; M. Trochon, microphysics of mists considered as aerosols; M. Roulleau, hygrometry; M. Rocard, kinetic theory of liquids; M. Hubault, pollution of waters, their industrial utilization and modifications of their fauna.

The Section of Civil and Military Engineering, under the presidency of M. Campus, was divided into three subsections: theoretical and applied hydraulics; navigable channels and ports; hydraulic works. One session was devoted to colonial hydrography.

The Section of Physics heard communications, among others, from Profs. F. Joliot and F. Perrin. The work of the Section of Geology was completed by field excursions; the Section of Botany also had excursions in which the Royal Society of Botany of Belgium and the Liège Botanical Circle joined.

The Sections of Biogeography and of Zoology held several joint sessions, with papers on the biology of equatorial lakes (M. Damas), the relations between the internal and external media in aquatic animals (M. Florkin), and the phreatic fauna (M. R. Leruth).

Mention should also be made of the communications presented to the Section of Geography (streams, their utilization and management, demographic and social aspects of water); and to the Sections of Medical Sciences (metabolism of water), of Psychology and Pedagogy, of Radiology and of Odontology.

Special subsections considered technical applications of water, applications of electricity, archæology and folklore.

The communications presented at the meeting will form a special volume published in connexion with the Liège meeting.

The French Association will meet in 1940 at Nice, some time in July, under the presidency of Prof. Pieron, professor at the Collège de France, and director of the Institute of Psychology of the University of Paris.

SOCIAL AND INTERNATIONAL RELATIONS OF SCIENCE

THE first annual report of the Division for the Social and International Relations of Science of the British Association, founded by resolution of the General Committee of the Association in August 1938, was presented at Dundee and is printed with the Report of Council of the Association.

A statement of the aims and objects of the Division, together with a request for information on any work in the field of social relations of science, was circulated to some three hundred and fifty associations, institutions and learned societies in the British Isles and abroad. The replies received indicated that much work of this nature has been done, or is in progress, and in certain instances opportunity has already been found for the Division to exercise its function of co-ordination. Many offers of co-operation were received from bodies particularly interested in the social impacts of science, and several valuable

contacts have been made. Notably, the Division learned that P E P (Political and Economic Planning) proposed to prepare a report on the organization of research in Great Britain, but was hampered by lack of funds to start the work. The Council of the Association, at the instance of the Divisional Committee, voted £100 as salary for the research worker appointed by P E P to collect the factual material. This enabled the work to proceed immediately, pending the acquisition of funds to maintain the inquiry from other sources. The necessary support has since been obtained from the Leverhulme Trustees, who have made available sufficient funds to carry on the inquiry until the autumn of 1940. The Division is represented on the committee supervising the work and will be associated with the report to be published in due course.

Some of the topics submitted to the Division for attention were referred to sections of the Association, and as a result several discussions and papers were arranged for the Dundee meeting.

A number of sub-committees have been appointed to deal with specific aspects of the Division's activities. One of these is considering the desirability of supplementing existing national research organizations whether in normal circumstances or in times of emergency. With the view of ascertaining details concerning systems of controlling and distributing grants in aid of research in other countries, an inquiry was directed to correspondents in the United States, France, Belgium, Holland, Denmark and the Dominions. Memoranda have been prepared by Prof. A. C. G. Egerton, and by Prof. J. D. Bernal and Dr. Julian Huxley, respectively, dealing with expenditure of public funds on research and discussing the question of a Research Co-ordination Council.

The sub-committee on nutrition and agriculture was responsible for a meeting at Reading to discuss milk in its nutritional and allied aspects. A resolution put forward from this meeting to the Council of the Association runs as follows:

"In view of the proved danger of the spread of epidemic and other diseases by the consumption of raw milk, of the efficiency of controlled pasteurisation in abolishing this danger and of the slight damage to the nutritive and other properties of milk caused by effective pasteurisation, it is essential for the national health that it be made compulsory in all urban areas with a population of 20,000 or more to pasteurise effectively all milk before sale to consumers to ensure its safety and to assist in securing that increase in the *per capita* consumption of liquid milk which is essential for improvement in the national level of nutrition." The Council, after consideration and consultation with the Nutrition Sub-Committee, considered it desirable that before taking any action on this resolution, a factual report on the whole question of the pasteurisation and sterilization of milk should be procured, and steps are being taken to do this.

Other sub-committees have been appointed to consider the economic requirements of nations, the influence of scientific and technical developments on industry, and on social psychology.

A Finance Sub-Committee made a recommendation to the Council of the Association that consideration should be given to the desirability of an appeal for funds to (*a*) private individuals and firms, (*b*) trusts at home, (*c*) trusts abroad, (*d*) H.M. Government. The Council adopted this recommendation, with the provision that of these possible sources, the first-named should be first explored.

Meetings arranged by the Division were held during the past year at the University of Reading, in London at the Royal Institution, and at the University of Manchester.

RADIO EXHIBITION, OLYMPIA

THE exhibition of radio apparatus organized annually by the Radio Manufacturers' Association was opened at Olympia on August 23 and is remaining open each weekday until September 2. This year's exhibition was conspicuous for the greatly increased attention and interest devoted to television receivers and also to several somewhat novel features which had a strong appeal to the more technically minded members of the public.

As regards the general display of sound broadcasting receivers, no fresh and outstanding change in technical design was in evidence this year. The large variety of models shown indicated that manufacturers have devoted attention for once to a steady improvement in efficiency and reliability, and the listener who is more concerned with service than with novelty may be assured that he can buy a new set with complete confidence. Most manufacturers now supply some form of 'push-button' tuning selection as part of one of their standard designs. A notable increase in the number and variety of portable receivers shows that there is a maintained demand for this type, and an innovation this year is the portable receiver operated entirely from dry batteries. This is the result of the introduction during the past year of new types of valves with a very low filament current consumption, so that a complete receiver may be operated under normal average conditions for several months, without changing or re-charging batteries.

It was in the field of television that the most marked change was evident in this year's exhibition of receivers. Most manufacturers' are now in a position to supply several types of television receivers, and these range from the table model with a small although very clear picture, up to an imposing cabinet model with a picture size about 24 in. × 18 in. In all cases frequent daily demonstrations were given on the manufacturers' stands, while, in addition, a specially arranged 'television avenue' enabled the visitor to inspect some fifty different models in operation on the same programme and so judge their relative merits. Considering that, so far, television reception is limited in Great Britain to the programmes radiated from the one station at Alexandra Palace, the prospective purchaser of a receiver was very well catered for at the exhibition.

Among the conspicuous features of the layout of this year's show were the uniform flat-roofed stands, and also the models of Broadcasting House and the

Alexandra Palace tower at opposite ends of the main hall. The B.B.C. provided several technical exhibits, including a television studio and control room in operation. A sound-recording van, complete with studio and associated apparatus, a motor-car fitted up for film recording purposes, and the 80-ft. telescopic aerial of the mobile television unit were also part of the display provided by the B.B.C. The Post Office demonstrated apparatus used for short-wave radio telegraph and telephone purposes, and illustrated the various stages in the dispatch and receipt of telegrams. Other novel features included technical exhibits by the radio departments of the services, such as field equipment as used by the Royal Corps of Signals, a replica of the wireless office of a destroyer by the Royal Navy, and a layout of the various electrical and radio equipment of aircraft by the Royal Air Force. An interesting and popular feature on the stand of the latter service was a 'link trainer', designed to represent the cockpit of a modern aircraft. It contains all the controls and equipment of a real cockpit, and with it all conditions of flying can be simulated on the ground. The exhibit was used to demonstrate the manner in which a pilot may fly in fog or at night, navigating entirely with the aid of wireless instruments receiving signals from beacons on the ground.

Reverting to the manufacture and production of ordinary broadcasting receivers, a number of firms had contributed to the model factory which was set up in the exhibition. Various stages in the assembly and production of receivers or their components were shown in full operation under normal factory conditions. In addition, the various stages in the assembly of several manufacturers' standard receivers were shown on a rotating drum model in continuous operation. This section of the exhibition was designed not only to interest the technical enthusiast but also as an attempt to induce the ordinary listener to learn something of the internal construction and mode of operation of his receiving set.

Altogether, the exhibition demonstrated a successful attempt on the part of the organizers to make a wider appeal to the broadcast listening public, and it was extremely unfortunate that it was held during a period of such acute international tension.

R. L. S.-R.

DENTITION OF AUSTRALOPITHECUS (PLESIANTHROPUS)

A COMPARATIVE and phylogenetic study of the dentition of the extinct South African man-ape *Australopithecus* (*Plesianthropus*) *transvaalensis* Broom has been made by W. K. Gregory and Milo Hellman, who visited South Africa in 1938 at the invitation of Dr. Robert Broom and Prof. Raymond Dart to examine the evidence at first hand for this purpose (*Annals of the Transvaal Museum*, **19**, 4; 1939).

One of the most astounding features of the type *A. transvaalensis* is the combination of a natural braincast, which is somewhat smaller than that of a large gorilla, with a dentition of almost human appearance. According to the experience of palæontologists the material available, though insufficient to satisfy statistical requirements, is adequate for determining the systematic position of Plesianthropus among the higher primates; and it is affirmed with Broom that in South Africa there once lived apes which had almost become men.

In the female Plesianthropus the premaxillary prognathism is much more pronounced than in the Ramapithecus from the Siwalik Hills, though the latter is a much smaller and more delicately built form. As compared with Sinanthropus the premaxillo-maxillary regions of Plesianthropus are more prognathous. Likewise in the lower jaw, the available evidence indicates that the forepart of the jaw in Paranthropus was shorter and more retracted than in the apes, and was approaching the stage of Sinanthropus. In this respect Paranthropus was structurally intermediate between the existing apes and primitive man. The excessive thickness of this jaw and the extreme flattening of the facial plate are unique characters, which though by no means excluding Paranthropus from the dryopithecine stock, are conspicuous differences from Sinanthropus and other hominids, and tend to justify Dr. Broom's choice of the name Paranthropus as indicating a side branch of the pre-human stock.

Turning to the evidence of the teeth themselves, the upper central incisor of Plesianthropus is unknown, but indications point to a derivation from certain conditions present in Siwalik dryopithecines, and from this stage the Sinanthropus-Mongoloid series (with extreme shovel-shaped first and second incisors) is derivable merely by further emphasis in the same direction. In modern man further emphasis of the method of growth produces peg-like crowns, while an emphasis on the basal swelling sometimes produces results observable in Palæanthropic man and some modern apes. Hence in respect to the stage of evolution of the upper permanent incisors Plesianthropus was intermediate between the ancestral dryopithecine stock and the primitive palæanthropic man; and it was more primitive than most modern anthropoid apes.

In regard to the canines Plesianthropus, starting from a primitive dryopithecine stage, was again approaching human conditions in the form and relations of its upper and lower canines. The small size of the canine teeth favours the conclusion that the small size of the canines in modern man is due to a secondary reduction. The lower canines are closer to Sinanthropus than to Sivapithecus. The edge-to-edge bite of upper to lower canines is again a primitive hominid condition, though occurring occasionally in old, very much worn, ape teeth.

In all the features of the premolars Plesianthropus was again intermediate between the primitive dryopithecus and the early human stage. Its upper premolars are more primitive than those of Sinanthropus in having lower, less taurodont, crowns and divergent buccal and lingual roots.

The molars, both upper and lower, in the South African fossil man-apes are unusually large, being exceeded only by *Sivapithecus giganteus* and by male gorillas. They differ, however, from those of gorilla, chimpanzee and other modern apes by certain easily recognizable peculiarities. In several respects their pattern has progressed towards the primitive human stage. It is not improbable that the great size of the third upper and lower molars was only a temporary phase preceding the reduction of these teeth in man.

The evidence from the Taungs infant is completely concordant with that of the Sterkfontein and Kromdraai adults, namely, that there lived in the upper Pleistocene of South Africa a group of small-brained man-apes that were derived from the widespread dryopithecine stock and were the less progressive cousins of man.

EIGHTH INTERNATIONAL CONGRESS OF REFRIGERATION

PLANS are being made to hold an international refrigeration congress at Cologne and Berlin during July 1–6, 1940. These congresses are held at intervals of about four years under the auspices of the International Institute of Refrigeration, which was set up by an international convention in 1920 and is supported by the majority of the nations.

After the Hague Congress in 1936, the scientific and technical side of the work of the International Institute of Refrigeration was reorganized and the control of that work entrusted to seven commissions, under a technical board composed of the presidents of the commissions dealing with various aspects of refrigeration. The reorganization became effective in 1938, when meetings of the commissions and technical board were convened in the rooms of the Royal Society. A one-day Conference on Refrigeration was also held following these meetings, and at this conference a number of papers were read which had been selected to embrace topics of especial interest to refrigerationists.

On July 14–16 last, similar meetings were held at Baden Baden and Karlsruhe, Germany. At the meetings of the technical board, a draft programme for the 1940 Congress was outlined.

On July 15, a Conference on Refrigeration took place at the Technical University at Karlsruhe, which has a department dealing with the engineering and physical side of refrigeration. In the grounds of the University is situated the Reich Institute of Foodstuff Preservation which is under the Ministry of Agriculture.

At the Refrigeration Conference four papers were read. Georges Claude dealt with the production and utilization of krypton. He indicated the advantages of the use of krypton for filling incandescent lamps, and stated that the production must be a separate field of activity rather than a by-product from liquid oxygen. G. Maiuri described machines working on the absorption principle and diffusing the refrigerant vapour in an inert gas. He stated that it is possible to attain temperatures below — 100° C. Ezer Griffiths dealt with various forms of hygrometers adapted to meet special requirements, and with humidity control. R. Plank dealt with air-conditioning in deep mines.

The meetings of the Technical Board were attended by representatives of various nationalities, and at the Refrigeration Conference there was a good attendance of German refrigerationists.

THE CAUSATION OF APPENDICITIS

APPENDICITIS is an inflammation around the cæcum, involving the vermiform appendage, and frequently associated with perforative ulceration. Previous to 1900, the disease was generally described under the names 'typhlitis' and 'perityphlitis'. The modern term 'appendicitis' began to be used in America between 1890 and 1900, and as a cause of death it first appears in the Registrar-General's annual report for 1901.

The immediate cause of appendicitis is a bacterial infection, but although the disease is a common one, the causes that predispose or precipitate an attack still remain but little understood, though stagnation of the intestinal contents in the appendix resulting in the formation of hard concretions is probably an important factor in many cases. There is a certain amount of information which suggests that habits of life, and in particular dietary habits, are of importance in predisposing to the disease.

In an endeavour to elucidate the causation of appendicitis, Dr. Matthew Young and Mr. W. T. Russell have surveyed the mortality statistics of Great Britain and of other countries and the statistics of certain hospitals, and their report is now published ("Appendicitis: A Statistical Study". Medical Research Council, *Special Rep. Series*, No. 233. H.M. Stationery Office. 1*s.* net). The figures relating to the frequency of appendicitis confirm that it is very prevalent and that it has been on the increase in recent years. Another point brought out is that the mortality in the highest social class is at least two and a half times greater than in the poorest social class, although the majority of diseases, especially those involving bacterial action, are commoner among poorer people. A curious feature of the mortality rates from appendicitis in women is that the figures strongly indicate that the mortality is greater among single than among married women.

The suggestion has been made that the nature of the diet may have an influence in predisposing to appendicitis, either an excess of food or possibly certain types of food, and both of these factors are probably more common among the well-to-do. The taking of purgatives or laxatives is another cause suggested, and this practice is probably more common in the higher social class and among women. No data bearing on these factors were obtained, though it is significant that the mortality from appendicitis in females fell during the war years 1915–18, when food restrictions were imposed, and increased afterwards.

THE BRITISH ASSOCIATION, 1839

On September 7, 1839, the *Athenæum* said: "The Birmingham Session of the British Association closed its peaceful labours on Saturday, and the many distinguished persons who had there met in furtherance of one common object—the advancement of science, and the good of all mankind—are already scattered far and wide, not less content, we hope, because a leading political journal has been pleased to pour out on them its vials of wrath and scorn—how justly, our readers can now determine. . . ."

The meeting had been presided over by the Rev. William Vernon Harcourt (1789–1871), a son of Edward Harcourt (1757–1847), archbishop of York, and the father of Sir William Harcourt (1827–1904), the statesman. Harcourt served in the Navy for five years before entering Christ Church, Oxford. Taking holy orders in 1811, he held various ecclesiastical appointments in Yorkshire, and in 1824 was elected F.R.S. He took an active part in the founding of the British Association, was the first general secretary, and at the inaugural meeting gave an address in which he said: "I propose to you to found an Association including all the scientific strength of Great Britain, which shall employ a short time every year in pointing out the direction in which the researches of science should move, in indicating the particulars which most immediately demand investigation, in stating problems to be solved and data to be fixed, in assigning to every class of mind a definite task, . . . I am not aware that in executing such a plan we should intrude on the province of any other institution. Consider the difference between the limited circle of any of our scientific councils . . . and a meeting at which all the science of these kingdoms should be convened, which should be attended by deputations from every other society, and in which foreign talent and character should be tempted to mingle with our own. With what a momentum would such an Association urge on its purpose; what activity would it be capable of exciting."

A great part of Harcourt's presidential address in 1839 was devoted to the Antarctic Expedition and magnetic observations, but towards the end, he said: "The system of your meetings, Gentlemen, has brought together things which ought never to be disjoined—the principles of science, with their application to human use. After gathering your first members from our ancient schools of learning, you passed to the marts of commerce, and are now come to the heart of the manufacturers of England, and look around on all the resources and creations of mechanical art. The theorist and the mechanician here meet together to the mutual advantage of both; witness on the one part the instrument now working in the Philosophical Institution of this town, and almost supplying the place of a constant observer, which is about to measure the force of the wind at every instant of time, at St. Helena, the Cape of Good Hope, Van Dieman's Land and near the South Pole. But here I would not go further than the immediate vicinity of this town for an instance, the most striking on record, of the mighty influence which the introduction of a new principle in science can exercise on all the arts of life; the history of the improvement of the steam engine by Watt fully illustrates this truth. . . ."

FORTHCOMING EVENTS

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (DUNDEE MEETING).

Sunday, September 3

At 8.30 p.m.—Sir Richard Gregory, F.R.S.: "Contacts of Religion and Science" (Division for Social and International Relations of Science).

Monday, September 4

At 10 a.m.—Dr. C. H. Desch, F.R.S., Dr. A. G. G. Gwyer, Prof. A. von Zeerleder, W. C. Devereux: "Light Alloys" (Discussion: Section B).

Dr. G. P. Douglas, Dr. A. Busemann, Dr. J. W. MacColl, C. N. H. Lock: "Problems of High-Speed Flight" (Discussion: Section A).

Prof. W. M. H. Greaves, Prof. R. W. Ditchburn, Dr. H. R. Hulme, Dr. D. Chalonge, Dr. R. v. d. R. Woolley: "Surface Temperatures of Stars" (Discussion: Section A†).

Prof. H. H. Read, F.R.S.: "Metamorphism and Igneous Action" (Section C: Presidential Address).

Prof. L. M. Fraser, Prof. A. G. B. Fisher, R. L. Hall: "The Economics of Socialism" (Discussion: Section F).

Prof. R. A. Fisher, F.R.S., Dr. D. C. Wilson, D. M. Lubbock and Dr. I. Leitch: "Nutrition and Physique" (Joint Discussion: Sections H and I).

T. Thomson, Dr. R. Melville: "Seed Provenance, Local Races and Breeding of Forest Trees (Joint Discussion: Section K and K*).

T. M. Herbert, Dr. W. G. Radley: "Aspects of Industrial Research" (Discussion: Section L).

M. Jones, Dr. S. J. Watson, E. J. Roberts and Prof. W. Kerr: "Grass Conservation" (Discussion: Section M).

R. S. Finlow, J. K. Eastham, J. R. Walker, A. King, W. E. Billinghame, J. K. Anderson: Second Special Session on Jute.

At 11.15 a.m.—Prof. W. McClelland, W. A. F. Hepburn: "Recent Educational Research in Scotland" (Discussion: Section L).

At 2.15 p.m.—Prof. F. G. Baily, Sir Robert Robertson, F.R.S., Dr. R. W. Butcher, W. Malloch: "River Pollution" (Discussion: Conference of Delegates of Corresponding Societies).

At 3 p.m.—Prof. G. Murray, Prof. F. G. Donnan, F.R.S., Dr. J. S. Huxley, F.R.S., Prof. G. Dahlberg: "International Intellectual Co-operation" (Discussion: Division for Social and International Relations of Science).

At 6.30 p.m.—Dr. H. W. Melville: "New Lamps for Old" (Popular Lecture).

Tuesday, September 5

At 10 a.m.—Prof. M. Born, F.R.S., Dr. Ezer Griffiths, F.R.S., Dr. W. H. Hatfield, F.R.S., W. J. Todd, Dr. R. W. Powell, J. H. Awbery, Prof. J. Satterly: "High-Temperature" (Discussion: Section A).

Dr. E. V. Appleton, F.R.S., H. W. Newton, A. D. Thackeray, Prof. L. Vegard, Prof. W. M. H. Greaves, Prof. F. J. M. Stratton: "Solar and Terrestrial Relations" (Discussion: Section A†).

Prof. A. McKenzie, F.R.S. and Dr. R. Roger, Prof. M. Tiffeneau, Dr. S. F. Birch, Dr. A. K. Mills, Dr. T. S. Stevens: "Intramolecular Change involving the Migration of Groups" (Discussion: Section B).

Prof. H. O. Meredith: "Rates and Taxes" (Presidential Address: Section F).

Prof. D. Burns, Dr. I. H. Pearse, Prof. E. P. Cathcart, F.R.S.: "The Assessment of Physical Fitness" (Discussion: Section I).

R. Knight, J. L. Hardie, Dr. R. H. Thouless, Dr. C. A. Mace: Training the Mind" (Discussion: Section J).

Miss L. Grier, J. B. Frizell, A. E. Henshall, D. E. Collier: Discussion on the Spens Report (Section L).

T. A. Wedderspoon, Dr. G. Cockerham, Dr. T. McIntosh: "Seed Potato Growing" (Discussion: Section M).

At 10.30 a.m.—Dr. M. Macgregor, Dr. W. Q. Kennedy, Prof. G. Hickley, F.R.S., Prof. T. N. George, Prof. W. T. Gordon, Dr. T. S. Westoll: "The Boundary between the Old Red Sandstone and the Carboniferous" (Discussion: Section C).

At 2 p.m.—Colonel R. B. Campbell, Miss H. Drummond, Prof. A. Hemingway and H. R. Noltie: "Physical Fitness" (Discussion continued: Section I).

At 3.30 p.m.—N. F. Sheppard, Prof. H. J. Fleure, F.R.S.: "Anthropology in Education" (Discussion: Section H).

At 8.30 p.m.—Dr. Isaiah Bowman: "Science and Social Pioneering" (British and American Association Lecture).

Dr. D. A. Spencer: "Some Aspects of Colour-photography" (Public Lecture).

Wednesday, September 6

At 10 a.m.—Sir John Orr, F.R.S., L. Harris, D. Lubbock, Prof. P. Sargent Florence: Discussion on Nutrition (Division for Social and International Relations of Science).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

RESIDENT ENGINEER (temporary) of a Small Arms Ammunition Factory at Cullane, Co. Clare—The Secretary, Department of Defence, Parkgate, Dublin, N.W.5 (September 8).

ASSISTANT LECTURER in the Mathematics and Physics Department—The Principal, Municipal Technical College, Halifax (September 8).

ASSISTANT TRANSPORTATION SUPERINTENDENT (Rolling Stock), Traction Branch of the Great Indian Peninsula Railway—High Commissioner for India, General Department, India House, Aldwych, W.C.2 (quoting 1/30A) (September 15).

LECTURER AND CHIEF DEMONSTRATOR IN ZOOLOGY in the Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 88a Gower Street, W.C.1 (October 1).

GRADUATE LECTURER IN MECHANICAL ENGINEERING in the Royal Technical College, Salford—The Director of Education, Education Office, Salford 3, Lancs.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Home Office, Ministry of Health and Scottish Office. Final Report of the Inter-Departmental Committee on the Rehabilitation of Persons Injured by Accidents. Pp. vi+194+8 plates. (London: H.M. Stationery Office.) 3*s.* 6*d.* net. [118

County Council of the West Riding of Yorkshire. Report on a Study of the Diets of 205 Families in the West Riding of Yorkshire. Pp. 26. (Wakefield: County Hall.) [128

The Harper Adams Adviser. Advisory Report No. 14: A Review of Advisory Work in the West Midland Province, 1938–39. Pp. 20. (Newport, Shropshire: Harper Adams Agricultural College.) [128

Seventy-fifth Annual Report on Alkali, etc. Works. By the Chief Inspectors. Proceedings during the Year 1938. Pp. iii+59. (London: H.M. Stationery Office.) 1*s.* net. [168

Forestry Commission. Bulletin No. 14 (revised 1939): Forestry Practice; a Summary of Methods of Establishing Forest Nurseries and Plantations with Advice on other Forestry Questions for Owners and Agents. Pp. 99. (London: H.M. Stationery Office.) 1*s.* 6*d.* net. [178

Edinburgh and East of Scotland College of Agriculture. Calendar for 1939–1940. Pp. 96. (Edinburgh: Edinburgh and East of Scotland College of Agriculture.) [218

British Association for the Advancement of Science. A Scientific Survey of Dundee and District. Prepared for the Dundee Meeting, 1939, by various Authors. Edited by R. L. Mackie. Pp. 124. (London: British Association.) [218

British Association for the Advancement of Science, Dundee Meeting, August 30–September 6, 1939. Official Guide to the City and its Environs. Edited by R. J. Mackie and J. B. Salmond. (Published for the Local Executive Committee.) Pp. 136. (Glasgow: John Menzies and Co., Ltd.) [308

Other Countries

The Rockefeller Foundation. Annual Report, 1938. Pp. x+311. (New York: The Rockefeller Foundation.) [118

Union of South Africa: Department of Mines, Geological Survey. The Geology and Mineral Deposits of the Omaruru Area, South West Africa; an Explanation of Sheet No. 71 (Omaruru, S.W.A.). By Dr. S. H. Haughton, Dr. H. F. Frommurze, Dr. T. W. Gevers, C. M. Schwellnus and P. J. Rossouw. Pp. 152. (Pretoria: Government Printer.) 5*s.*, including Map. [128

Department of Agriculture, Mauritius: Sugarcane Research Station. Bulletin No. 15: The Inheritance of Gumming Disease Resistance in Sugarcane Breeding. By G. C. Stevenson. Pp. 9. (Port Louis: Government Printer.) 15 cents. [128

Tanganyika Territory. Department of Lands and Mines: Land Division. Annual Report 1938. Pp. 12. 1*s.* Department of Lands and Mines: Mines Division. Annual Report 1938. Pp. 36. 1*s.* Department of Lands and Mines: Survey Division. Annual Report 1938. Pp. 22. 1*s.* (Dar es Salam: Government Printer.) [128

Annual Report of the Public Health Commissioner with the Government of India for 1937. Vol. 2. Pp. vi+157. (Delhi: Manager of Publications.) 2.6 rupees; 4*s.* [148

Smithsonian Miscellaneous Collections. Vol. 98, No. 21: The Weekly Period in Washington Precipitation. By C. G. Abbot and N. M. McCandlish. (Publication 3547.) Pp. ii+4. (Washington, D.C.: Smithsonian Institution.) [148

U.S. Department of the Interior: Office of Education. Bulletin, 1938, No. 11: Principles and Procedures in the Organization of Satisfactory Local School Units. By Henry F. Alves and Edgar L. Morphet. (Local School Units Project.) Pp. vii+164. (Washington, D.C.: Government Printing Office.) 25 cents. [148

Bulletin of the Department of Zoology, Panjab University, Vol. 2. Fauna of the Dal Lake, Kashmir. 1: On some Leeches from the Dal Lake, Kashmir. By Dr. M. L. Bhatia. Pp. 17+1 plate. (Lahore: University of the Panjab.) 1 rupee. [148

Pasteur Institute of India. The Thirty-seventh Annual Report of the Director of the Institute for the Year 1937. Part 2. Pp. 68. (Kasauli: Pasteur Institute of India.) [148

Tanganyika Territory. Department of Lands and Mines: Geological Division. Annual Report 1938. Pp. 27. (Dar es Salaam: Government Printer.) 1*s.* 6*d.* [148

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des réunions. Vol. 110: Contributions to Special Scientific Meetings, 1939. Pp. 112. (Copenhague: Andr. Fred. Høst et fils.) 6.00 kr. [148

Geological Survey of British Guiana. Bulletin No. 13: Report on a Short Visit to Marudi Mountain Gold Workings, Rupununi District, 1934. By Dr. D. R. Grantham. Pp. ii+5+1 plate. (Georgetown: Geological Survey.) 12 cents. [148

Report of the Haffkine Institute for the Year 1938. By Lt.-Col. S. S. Sokhey. Pp. iii+90. (Bombay: Government Printing and Stationery Office.) 3 annas; 4*d.* [148

Government Museum, Trivandrum. Annual Report, 1113 M.E. Pp. 8. (Trivandrum: Government Museum.) [168

Smithsonian Miscellaneous Collections. Vol. 98, No. 29: The Determination of Small Amounts of Chlorophyll—Apparatus and Method. By Earl S. Johnston and Robert L. Weintraub. (Publication 3545.) Pp. ii+6+2 plates. (Washington, D. C.: Smithsonian Institution.) [168

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 26, Part 9: A Revision of *Besleria*. By C. V. Morton. Pp. vi+395–474+vii–ix. (Washington, D.C.: Government Printing Office.) 15 cents. [168

U.S. Department of Agriculture. Farmers' Bulletin No. 1823: Grasshoppers and their Control. By J. R. Parker. Pp. ii+38. (Washington, D.C.: Government Printing Office.) 10 cents. [168

American Anatomical Memoirs. No. 18: A Resurvey of the Developments of Lymphatics and Associated Blood Vessels in Anuran Amphibia by the Method of Injection. By Henry McElderry Knower. Pp. 125 (19 plates). (Philadelphia: Wistar Institute of Anatomy and Biology.) [168

N.Z. Department of Scientific and Industrial Research: Apia Observatory, Apia, Western Samoa. Annual Report for 1935. Pp. 145. (Wellington: Government Printer.) 6*s.* [178

U.S. Department of the Interior: Office of Education. Vocational Division Monograph No. 20: Discovering Occupational Opportunities for Young Men in Farming. By J. W. Hatch. Abbreviated and rearranged by F. W. Lathrop. Pp. iv+9. (Washington, D.C.: Government Printing Office.) 5 cents. [188

Commonwealth of Australia: Department of Health. Physical Aspects of Radium and Radon Therapy. By Dr. C. E. Eddy and T. H. Oddie. Second edition. Pp. 57. (Canberra: Government Printer.) [218

Survey of India. Geodetic Report, 1938. Pp. iv+86+11 charts. (Dehra Dun: Survey of India.) 3 rupees; 5*s.* [218

Royal Observatory, Hong Kong. Meteorological Results, 1938. Prepared under the direction of C. W. Jeffries. Pp. iv+142+41+6, 3 dollars. Report of the Director for the Year 1938. Pp. 8. 30 cents. (Hong Kong: Royal Observatory.) [218

Publikationer fra det Danske Meteorologiske Institut. Aarbøger. Isforholdene i de Arktiske Have (The State of the Ice in the Arctic Seas) 1938. Prepared by Helge Thomsen. Pp. 17+5 maps. (København: G. E. C. Gad.) [218

U.S. Departure of Agriculture. Leaflet No. 184: The Elm Leaf Beetle. By C. W. Collins. Pp. 6. 5 cents. Miscellaneous Publication No. 341: The Species of *Pantomorus* of America North of Mexico. By L. L. Buchanan. Pp. 40. 10 cents. (Washington, D.C.: Government Printing Office.) [228

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